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On the POST-TERTIARY DIATOMACEOUS SAND *of* GLENSHIRA. Part II. *Containing an account of a number of additional undescribed species.* By WILLIAM GREGORY, M.D., F.R.S.E., M.R.I.A., &c.; Professor of Chemistry in the University of Edinburgh. Illustrated by numerous figures drawn from Nature, by R. K. GREVILLE, LL.D., F.R.S.E., &c., and engraved by TUFFEN WEST, Esq. (Plate I.)

Continued from No. XVI, p. 48.

(Read March 26th, 1856.)

24. *Pleurosigma* (?), n. sp. This peculiar form, which is very scarce in the deposit, I have not ventured to name, although it cannot be referred to any of the species in Smith's Synopsis, vol. i.

Form very slightly sigmoid; extremities obtuse. The median line, as may be seen in vol. V, Pl. I, fig. 24, is central at one end, while at the other it seems to approach the margin for a short space just before the apex. This appearance is probably due to the circumstance that the valve does not in this case lie quite flat. There is an elongated oval expansion round the nodule, but imperfect; and I am not sure that this appearance may not depend on some injury to the valve. Length about 0·0053″. I have not been able to resolve the striation as yet, and I conclude that it is of the finest; but until I can examine several good specimens, the description must be imperfect. (281.)

25. *Cocconeis distans*, n. sp. This species was described in my former paper, but a form of *C. Scutellum* was by mistake figured for it; I therefore give a figure of it in fig. 25. Some, judging from the former erroneous figure, have supposed it to be only a form of *C. Scutellum*, but its whole aspect is so peculiar, that those who see the form, which is not very rare in certain densities, are at once struck with it as peculiar. Professor Kelland, without knowing of it at all, at once noticed it in some of the deposit which I prepared for him.

Form always a broad and pure oval. Length from 0·0008″ to 0·0018″. The transverse rows of dots are not above one half of the number of those in the largest and coarsest forms of *C. scutellum*, which abounds here in all its forms, and can be easily compared with *C. distans*. These lines, about 9 in 0·001″, are also formed of much fewer and larger dots, and these dots are all of equal size, except only that those at the margin are sometimes smaller. They are so distant, and the lines of them so few, that the form ceases to have a striated

aspect, and appears sparsely dotted. In *C. Scutellum*, of the same size, and of the coarsest variety, there are twice or thrice as many lines, and in each line three or four times as many dots as in *C. distans*. Moreover in *C. Scutellum*, which has the striated aspect in all its forms, the dots are of very unequal size, being smaller in the middle, and increasing in size towards the margin. Again in *C. Scutellum*, the form of this valve is very often, indeed generally, more or less angular, both in the middle and at the apices. In *C. distans*, the dots are quite round, and have a peculiar lustre, so that in a certain focus they appear white and translucent. I have seen this form in recent marine gatherings, but it is scarce. (218.)*

(Since the above was written I have observed another well-marked character in this species. The granules or dots are placed on faint white transverse bars, which, in some positions, or in some lights, are easily seen. I have also lately found *C. distans*, in considerable abundance, in a recent marine gathering, of which I hope to lay an account before the Society next season. In this gathering I have found two remarkable forms, which may perhaps both be varieties of *C. distans*, but one of which, though allied to it, is probably a distinct species. One of these has the faint white bars above described, and, on the whole, my observations tend to show that *C. distans* is not related to *C. Scutellum*.

I may here mention that *C. costata*, to be presently described, also occurs in the new recent gathering, and that this form also is entirely distinct from *C. Scutellum*, although Professor Smith, in his second volume, has conjectured it to be a form of that species.)

26. *Cocconeis radiata*, n. sp. This very beautiful form is rare in the deposit, compared with most of the others. It is represented in fig. 26.

Form oval. Length about 0·00075″. It has strong, distant rays, proceeding from a small, oval central spot, and, so far as I know, it is the only oval form which is radiated. The rays appear to increase in width as they approach the margin, and are crossed by a series of concentric elliptical lines, from the margin to the centre, giving to the valve a singularly rich appearance. Rays about 18; concentric ellipses about 7 or 8. This form has occurred as yet only in this sand. Fig. 26* represents an abnormal form of it. (282.)

27. *Cocconeis costata*, n. sp. This pretty species was described in my former paper, but the specimen there figured was an inferior one. I give a better in fig. 27. It is not rare in the lighter densities.

* So numbered in Part I.

Form a broadish oval. Length, 0·0005″ to 0·001″. Median line strong; no nodule. The transverse lines are strong entire costæ, which I formerly described as double lines. This is only apparent, something on the form of the costæ causing their margins to come out strongly. The space between each pair of costæ is striated at right angles to the costæ, a character only seen on close inspection, and which I have observed since my former paper. This is a perfectly characterised species, which I have found pretty frequent in the recent gathering above mentioned. (219.)*

28. *Cocconeis* (?) *lamprosticta*, n. sp. This form is somewhat scarce in the deposit, and I have considerable doubts as to its belonging to this genus. For the present, however, I place it there, as I have not yet been able to see any other view than the one figured, of which I have found a considerable number.

Form between elliptic and obtuse rhombic, inclining rather more to rhombic. The central nodule is not strongly marked, but the median lines terminate in two small expansions, between which is a considerable space. Length from 0·0028″ to 0·0033″. Striæ about 12 in 0·001″, very conspicuous, formed of dots, somewhat like those in *C. distans*, and as widely apart. There is a narrow blank space on each side of the median line. The dots have the same shining aspect as in *C. distans*, but the form is much thicker and more strongly marked.

The resemblance of this form, which is represented in fig. 28, to *C. distans* in several characters, led me to refer it to the same genus. But in some specimens, apparently of the same form, the median line is a mere blank or raphe, and the dots are rather square than round. These specimens, as Dr. Greville pointed out to me, seem rather allied to *Biddulphia* or *Zygoceros*, genera which possibly ought to be united, and which, at all events, are very imperfectly known. If the present form, fig. 28, belong to *Biddulphia*, it ought to exhibit the characteristic and peculiar front view of that genus; but for this I have sought in vain. It is possible that there may be two forms; one a *Cocconeis*, or possibly a *Navicula*, the other a *Biddulphia* or *Zygoceros*. I figure the most frequent, and leave the question to continued observation. (282.)

Before quitting this genus, I may mention, that in this deposit both *Cocconeis Scutellum* and *C. Placentula* are among the most abundant forms, and that both of them exhibit a remarkable extent of variation. According to many, the form I figured in my first paper as *C. speciosa* is a form of *C. Scu-*

* So numbered in Part I.

tellum, but I have considerable doubts on this point. The form figured by Roper as *C. concentrica* is referred in like manner to *C. Placentula*, but this also is doubtful. In the Glenshira Sand both of these are frequent; and there is another form, allied to *C. concentrica*, but differing still more from *C. Placentula*. This form is a curious one, but I have not yet been able to study it properly.

29. *Amphora* (?) *rectangularis*, n. sp. This is a pretty little form, which I refer to *Amphora* on account of the crossbar in the middle of each valve; otherwise I should have referred it to *Amphiprora*. Represented in fig. 29.

Form of the entire frustule nearly rectangular, narrow, with the corners somewhat rounded. The middle space is widest at the ends, and in the centre; narrower between these points. The striated portions are crossed by a straight bar, opposite to which the outline is slightly constricted. Length from 0·0025″ to 0·0045″. Striæ fine, transverse, about 40 in 0·001″. Besides the central constriction, the external margin is very slightly undulated towards the ends. (283.)

30. *Amphora elegans*, n. sp. This form is frequent, as is also the preceding; but it seldom occurs entire, and the figure, fig. 30, is that of the detached valve.

Form of the entire valve oval, elongated, with truncate extremities. Length from 0·001″ to 0·0025″. The two halves are separated by a rectangular space. The curve line in each valve is peculiarly gentle and beautiful. Each valve is crossed by a line or bar in the middle. Aspect hyaline; striæ very fine, transverse, inconspicuous.

(I have lately found it entire in the recent gathering above mentioned.)

31. *Amphora plicata*, n. sp. This is another hyaline species. Fig. 31 shows the entire frustule, which is frequent; but its parts are often shifted or displaced.

Form nearly rectangular; broad, corners rounded, ends truncate, the middle part of the outline being slightly convex or elliptical. In some it is quite straight. The curve line in each valve very deeply curved, the curve coalescing with the margin near the ends, and projecting much towards the nodules in the middle. The part of the valve external to this line is very faintly marked with transverse striæ, difficult to be seen, from the hyaline character of the form. The median space is marked by strong vertical, or rather concentric, slightly curved lines, which appear as folds, like those of paper plaited and then partly opened out. I have named it from this character. It is a beautiful and striking form, but apt to be overlooked from its transparency. (284.)

32. *Amphora biseriata*, n. sp. This is another remarkable species of the genus, which is not at all rare in the deposit. It is represented in fig. 32.

Form of the entire frustule nearly rectangular, the corners being rounded. Sometimes it is a little elliptical in the middle, at others it is a little incurved there. It is often rather narrow. Length 0·003″ to 0·0045″. The two valves are connected by a narrow rectangular space. The curve line in each valve is not conspicuous, from its projecting so very little from the margin in the middle part, and running very near the margin all the way to the ends. The striation is coarse, transverse; striæ about 18 in 0·001″. In each valve the striæ are traversed by faint white vertical lines, which are only seen when the focus is adjusted to them, and then appear to divide the striæ into vertical bands of short transverse bars. Sometimes two such lines are seen on each side. I have named it from this peculiarity; but it is well characterised by its form and peculiar striation.

I do not feel quite sure that I have rightly referred this form to *Amphora*; but the curve lines certainly exist, and there is no other known genus to which it can be referred. (285.)

33. *Amphora lineata*, n. sp. This form, which is represented in fig. 33, varies a good deal, and occurs sometimes much longer and narrower, without the recurved ends, and with more and stronger vertical lines in the median space. I have not had time to obtain figures of the other forms, and this one is not so characteristic as others.

Form oval, sometimes broad, at other times long and narrow, nearly linear. Ends recurved, but in some this is very slight indeed. Lateral parts distinctly cross striated. Median space marked with fine but distinct vertical, or rather concentric lines. The form here figured approaches to *A. salina*, Sm., but there are others which have no resemblance to that form, and in which the vertical lines are stronger, and cover the whole valve, so that no lateral transversely striated part can be seen. It is possible that the latter are the true *A. lineata*, and that the form figured may be a form of *A. salina*. Length from 0·0015″ to 0·0025″.

I am inclined to believe that the form I consider as the typical *A. lineata*, not here figured, is the same with a lineate Amphora which Dr. Greville has found in the sand from Trinidad already mentioned. (286.)

(In the recent gathering above referred to, I find the form which I call *A. lineata* frequent. I shall give a better figure of it on an early occasion.)

34. *Amphora obtusa*, n. sp. This is one of the most striking forms in the deposit, in which the detached valve, as seen in fig. 34*, is by no means rare; while the entire frustule, fig. 34, is very scarce. The detached valve has also occurred to Dr. Greville in the Trinidad sand above alluded to.

Form of the entire frustule nearly rectangular, broad, the ends very broadly rounded. The outline of the detached valve is generally a little convex on the outer margin, occasionally it is very slightly incurved there, as in fig. 34*. The ends of the valve are generally very obtuse, but, as in fig. 34*, sometimes produced to a sort of beak. The inner margin of the valve is gently undulated, so that it was not easy to suppose two of them in opposition till the entire frustule, fig. 34, occurred, in which the margin appears more nearly straight. The two valves are in close opposition, except at the centre and just at the ends; but I have also secn them separated by a narrow rectangular space. The curve lines are strongly marked and strongly curved, projecting in the middle nearly to the centre, and near the ends almost coalescing with the outer margin. There is a nodule at the middle point of each curve line, and also near each end of the valve; but here the outer margin seems to bend inward in a curl and form the nodule, which is apparently on a different plane from the rest of the inner curve line. Length about 0·0037″ to 0·004″. The valve is transversely striated. Striæ very fine, about 70 in 0·001″. They cannot be seen on all parts of the valve at the same time, because the valve is very thick, and the parts on opposite sides of the curve line are in different planes. (287.)

35. *Amphora crassa*, n. sp. This and the two following species possess a most remarkable and peculiar structure, which makes me very doubtful whether they belong to this genus. If they do, they will form a well-marked sub-genus. It is, however, possible that it may be found necessary to form a new genus for their reception. The first of them, *A. crassa*, is represented in fig. 35.

Form nearly rectangular, rather narrow; corners rounded, ends truncate. Length from 0·002″ to 0·0032″. The whole visible surface of the valve is divided into about eight vertical bars, which seem to converge on the ends. The curve lines project half way across each valve in the middle, but retreat rather suddenly to very near the outer margin, and run along it, almost coalescing with it. The vertical bars are transversely striated, and the striæ are coarse and broad, about the same width as those of *Pinnularia borealis*, Ehr. (*P. latestriata*, W. G.) There is no appearance of separation between the

two valves, nor have I seen the detached valves of this form. As its structure much resembles that of the next species, I shall not here dwell on it. (288.)

(In the recent deposit so often alluded to, I find *A. crassa* not unfrequent, and I have there seen the detached segments, which are very remarkable—so much, that I at first took them for an entirely new form.)

36. *Amphora Grevilliana*, n. sp. This form, of which the entire frustule is represented in fig. 36, and the detached valve, or rather segment, in fig. 36*, is the most remarkable of all the forms here described, as *Synedra undulata* was of those figured in the former Paper.

Form of the entire frustule varies from rectangular, to somewhat elliptical, or rather broad elliptical, with broadly truncate ends, the ends being convex. Length from 0·003″ to 0·0045″. Like the preceding, the whole surface of the frustule is made up of vertical, or rather concentric bars, the middle one appearing straight, the others slightly curved, and converging on the ends. There are blank lines or narrow spaces between these bars, of which there are seven or eight, not so closely set as in the last species. As in the last, the lateral curve lines project half way across each valve in the middle, but curve back rapidly to the outer margin, along which they run to the ends. The bars are transversely striated. Striæ conspicuous, but much finer than in *A. crassa*. The frustule has very much the appearance of a cask or barrel, but appears to be four-sided or prismatic, as seems also to be the case in *A. crassa*. Colour dark brown.

The detached segment, as seen in fig. 36*, is arcuate; the dorsal margin convex, and in some long specimens straight, bending forward at the ends to a kind of projecting beak. The inner margin, which is faint, is nearly straight, but between the central nodule and each end it is slightly incurved. Within it is a much more strongly marked and more incurved line, the two halves of which meet in a strong nodule. Beyond this again, is another line forming one curve, convex towards the inner margin in the middle, and concave at the ends. Beyond this is a still stronger line, which in the middle is concave towards the inner margin, and towards the ends is concave in that direction. The whole is marked with strong, conspicuous, moniliform, transverse striæ.

For a long time I did not connect the two forms, fig. 36 and fig. 36*. The latter I took for a form of *A. Arcus*, figured in my former Paper. But at last, when Dr. Greville pointed out some of the differences, I returned to the study of it, and soon found specimens of the entire form, fig. 36, in which

the markings of fig. 36* could be seen through them, as well as others, fallen in part asunder, which demonstrated the connection. I then named it in compliment to Dr. Greville, who had thus led me to trace the relation between the two forms.

But although it is certain that the form fig. 36* is a part of the entire frustule, fig. 36, it does not appear to be the half of that frustule, nor such a part or single valve as usually occurs in *Amphoræ;* for if we suppose two such parts in apposition, as we may see in *A. ovalis,* or in several of the *Amphoræ* I have here described, such as *A. obtusa,* the result would not be, as in *A. obtusa* or *A. ovalis,* the entire form, but something quite different. I have seen two segments thus in apposition, but too late to be figured. The effect is exactly that of a section through the middle of the supposed frustule, and resembles what is seen when an orange is cut in half. On the other hand, the entire frustule, as we see it in fig. 36, which, after all, may be but half of the entire form, appears as if it were formed of parts like fig. 36*, which are thicker on the convex margin than on the concave one, placed next each other in the same way as the parts or segments of a melon. Of such segments we see the backs of seven or eight in the view seen in fig. 36. But as the frustule is not cylindrical, though convex for a large part of its periphery, but rather prismatic, it is probable that there are two sides, like that seen in the figure, opposite to each other, and two others at right angles to these, also opposite to each other, and perhaps narrower. The former, the broader sides, are convex, like the sides of a barrel; the others probably flat. The latter most likely represent the rectangular median spaces in the common forms of *Amphora,* and the line of junction of the two half-barrels, as we may call them, will pass through these narrower sides. If this be correct, then the view, fig. 36, may be either that of the entire frustule or barrel, or that of the half-barrel seen from the convex side. I think I have seen specimens of all these views, namely, of the entire frustule, which is darker in colour, of the half seen from the convex side, and of the half seen from the flat side, or looking on the plane of a section through the middle of the narrower sides of the frustule. But I have not yet seen any specimen lying on the narrower side, and thus showing the line of junction. This is probably because the convex side is so much broader.

It will be seen that the bars, which are the thick backs of the segments, converge like those of an orange or melon, to a point on the terminal surface, which is therefore also con-

vex. I have not been able to see this surface as if looking directly down on it, although the form is not rare in the coarser densities; but I have no doubt that the frustules may be picked out and examined in water or some other fluid in which they can be turned round so as to show all the faces.

The above description applies, *mutatis mutandis*, to *A. crassa*, and, as I believe, also to *A. Arcus;* and although these forms all exhibit some points of agreement with *Amphoræ*, as hitherto known, yet the peculiarly complex structure of each half of the frustule seems to be a character so marked, as to require a new genus for those forms in which it is found. I do not, however, venture to establish such a genus, but am satisfied to direct the attention of observers to the existence of this remarkable structure, (which appears also to occur in *A. costata*, figured in the 'Synopsis,' vol. i,) in the hope that it may be more thoroughly investigated and more satisfactorily cleared up than I have been able to do it. I should here add, that possibly *A. biseriata*, the structure of which is both obscure and peculiar, may belong to this group, and that even *A. plicata* may be found to be related to it. (289.)

(*A. Grevilliana*, as well as the next species, occurs in the recent gathering already alluded to.)

37. *Amphora Arcus*, n. sp. Of this species, individual segments were figured in my former Paper. I had not then seen it entire; but since then I have found that one of the complex, barrel-shaped forms in the deposit belongs to it, and is either the entire frustule or half of it. Like *A. Grevilliana*, it varies considerably in length, but the entire or half frustules I have seen have been shorter than many of the detached segments. The general structure and form resemble those of the preceding species; but the segments are simply arcuate, having the form of a strung bow. The entire frustule has the form of a barrel with ribs and bars, and all parts are easily distinguished from *A. Grevilliana* by their coarser striation, and by the coarsely moniliform character of the striation. As the segments were formerly well figured, I give here a figure of what is not the entire form, but is more probably only one half of the barrel. This is represented in fig. 37. (213.)*

38. *Amphiprora minor*, n. sp. This species, represented in fig. 38, is not very rare in the deposit.

Form elliptical, long, and rather narrow, the central part slightly constricted. The inner margin of the lateral parts is concave towards the middle, leaving a long, narrow, truncate,

* So numbered in Part I.

elliptical median space. The lateral parts are marked with somewhat coarse transverse striæ. Length about 0·0025″. (290.)

39. *Amphiprora lepidoptera*, n. sp. This beautiful form is also not unfrequent in the deposit. It is in some degree allied to *A. alata*, but not only is it much longer, it has also a totally different aspect, not being hyaline as *A. alata* is, but conspicuous, from the absence of this peculiarity. It has also a brown colour. It is frequent in some densities, and very uniform in its characters.

Form nearly rectangular, with rounded ends, rather narrow, strongly and sharply constricted in the middle. The median space is broader than the lateral parts or alæ. There are well-marked nodules on each side where these parts meet and join the transverse terminal margins. The alæ are finely, but distinctly marked with transverse parallel striæ. Length from 0·004″ to 0·006″. Colour a clear brown, especially on the alæ. This is a very elegant form, but being thin, it is often met with fractured. It is shown, of a good deal less than the average length, in fig. 39. (291.)

(While this sheet was going through the press, I have ascertained that the form figured in the first part of this communication as *Apr. vitrea* β *?*, is the S. V. of *Apr. lepidoptera*. Professor Smith, in his second volume, refers it to *Apr. elegans*, from which, however, it is at once distinguished by the acute and apiculate extremities, as well as by its general aspect and finer striation.)

40. *Amphiprora recta*, n. sp. This is a smaller species, still more nearly rectangular than the two preceding. It is frequent in the lighter densities. An individual, a good deal broader than the form usually is, is shown in fig. 40.

Form nearly rectangular, very slightly constricted, or rather incurvate in the middle; the corners rounded, the ends flat. Median space wider at the ends than in the middle. Lateral parts transversely striated; striæ fine, but distinct. Length from 0·002″ to 0·0045″; breadth variable, the longest being always narrow. There is an appearance of a central nodule in each valve, besides the two terminal nodules; and the valve on the S. V. must look like a *Navicula* or *Pinnularia*. But I have not been able, though the form is very frequent, to see any S. V. which I could refer to it. At first I took the frustule for the F. V. of a *Navicula* or *Pinnularia*; but the halves are united as in *Amphiprora*; the striation extends over the greater part of the F. V.; and lastly, the valves, even when separated, do not lie on the S. V., as is almost invariably the case with those genera. I have therefore referred it to *Amphiprora*. (292.)

41. *Campylodiscus simulans*, n. sp. This is a fine form, and frequent in the coarser densities, though, like nearly all the forms described in this Paper, it has not yet occurred elsewhere.

(I find it in the recent gathering above referred to, and I am informed by M. de Brébisson that it is the same as his *A. Thuretii.* But as I had found and named it, and even communicated it to M. de Brébisson long before his Paper appeared, I retain my own specific name. M. de Brébisson's figure is not characteristic, or I should sooner have recognised the identity of the two forms.)

Form frequently orbicular, and also frequently exhibiting the peculiar flattening at one side, and pointed projection opposite, with the saddle-like flexure of the valve so characteristic of the genus. But the orbicular individuals often do not seem to possess this last character.

From two points, near to each other at the circumference, two lines proceed, diverging gradually to the middle, and converging again to two points opposite the first. These lines bound the median space which occupies, in the middle, about one fourth of the diameter. It is marked with coarse transverse striæ, divided in the middle by a blank line or raphe. From the margins of this space proceed, on each side, about twelve diverging lines, which, for rather more than a third of the distance to the circumference, are strong and black. Each line then splits into three, the two outer diverging a little, and near the margin meeting in a semicircular termination, and thus forming, on each of the short black lines, as a stalk, a lotus flower; the semicircular ends of these flowers meet all round, forming an ornamented inner margin. Beyond this lies a circular outer margin, and the short space between is transversely striated. At the points where the stalks of the lotus flowers divide, the third or middle line proceeds straight on from the stalk, and terminates abruptly just where the flower begins to expand into the head. Diameter from 0·003″ to 0·004″.

I have thus minutely described the markings of this form, which is well figured in fig. 41, because in my former Paper I figured another form, of a different genus, the markings of which are almost, if not quite identical with those of the form here described. That was figured as a large variety of *Surirella fastuosa;* and although I had not then studied the structure so minutely as I have since done, and the figure is not perhaps exactly as I would now make it, yet it will be seen that even that figure shows the resemblance.

The only difference, except that of form, which I can perceive is, that in the *Surirella,* the median space is narrower,

and not divided by a raphe. But it varies in breadth, even in the *Surirella*, and is probably only narrower there because the form is oval: and as to the form, the *Surirella* occurs frequently of so broad an oval as to be all but orbicular. Then, as we have seen, the *Campylodiscus* is most frequently orbicular, and not saddle-shaped. Indeed, as the *Surirella* varies much in form, being often panduriform, I think it quite possible that it may also occur orbicular, or as nearly so as the *Campylodiscus* I have figured.

The question here arises—Is it possible that these two forms should belong to the same species? And I am not prepared to answer this question in the negative. It is true that at present they are in different genera; but I would remind the student of these forms, that not long ago, nay, perhaps even now, *Campylodiscus spiralis*, as we call it, figures in Continental works as *Surirella flexuosa*. There is, therefore, a natural affinity between the genera, if really different; and in that case, *C. spiralis* and the form here described may be forms exhibiting the transition from one genus to another; it seems, however, more probable, that there may be no essential distinction between these genera. I have omitted to state that both forms, the *Surirella* and *Campylodiscus*, are equally frequent in the Glenshira Sand. (293.)

42. *Campylodiscus bicruciatus*, n. sp. This beautiful form is by no means so frequent in the deposit as the preceding. Fig. 42 represents it.

Form nearly orbicular. Median space square, marked with two sets of coarse lines, at right angles to each other, giving to this part a fenestrate appearance.* From each side of this square proceed two triangular or conical prongs, or prolongations to the inner margin, which their points touch. These prongs are strongly striated, each pair transversely to its course. From the corners of the square proceed, from each corner four lines to the inner margin, which, as in the preceding species, is formed of small semicircles, convex outward, and joining the points of the sixteen lines and those of the

* I have some reason, from recent observations, to suspect that the fenestrate aspect may depend on the fact, that the two valves are so placed, that the lines in one are at right angles to those in the other. If so, this is probably the normal position, for I have not seen any example of the valves lying obliquely. Of course, in the supposed case, the single valves will exhibit only four prongs; and this I think I have seen. But, if this be the case, it is not easy to see how, if the cross bars are seen through the upper valve, the open spaces should come out as clear as if the two valves lay with the bars coincident. Mr. West informs me that he has seen this form in an exotic marine gathering.

eight prongs, forming spaces, which differ in shape from the different origin of the boundary lines. Between the inner margin and the outer one, the narrow space is transversely striated. Diameter of disc about 0·027″. (294.)

43. *Tryblionella apiculata*, n. sp. In my former paper I figured *T. constricta*, which name I find has been adopted by Professor Smith. I had also observed this one, but had not then satisfied myself that it was distinct. Having since then found it in recent gatherings, alone, that is, without the shorter *T. solæiformis* or *constricta*, I am inclined to regard it as distinct, especially as I understand that Professor Smith thinks that I had included two forms under *T. constricta*. I may here add that Dr. Greville has found in the Trinidad sand, a short, broad, slightly constricted and apiculate form, which seems to be a *Tryblionella*, allied to these. This last I have also since observed in the Glenshira Sand, though perhaps a little smaller. It is possible that all three may be forms of one species. Fig. 43 represents *T. apiculata*.

Form linear, narrow, slightly constricted in the middle; extremities apiculate. Keel strongly marked in many specimens, striæ fine but distinct, about 45 in 0·001″. Length 0·0015″ to 0·0017″. The striation is peculiar, for in many specimens it is easy to see not only transverse, but also oblique striæ. This character was first observed by Dr. Greville in the Trinidad form, so far as I know, but I have since observed it in all the forms, though not in every individual. These forms require a more full investigation than I have been able to give to them. That here figured, or one apparently the same, occurs in a recent gathering from the Cumbrae Isles in the Clyde, with only fresh-water forms, but so near the sea, that the *Tryblionella* may possibly be marine. In Dr. Greville's Trinidad sand, both marine and fresh-water forms occur. (295.)

44. *Nitzschia distans*, n. sp. This form is frequent in the deposit; want of space, however, has prevented its being given on this plate.

Form of the F. V. rectangular, the corners rounded. In some specimens I observe a small expansion, analogous to that in *N. spathulata*, but smaller, on each side near the extremities. This is not seen in the figure, having probably been absent from the individual figured, or not seen by the artist from its transparency. The markings are unusually distant, hence the name. They appear to be almost moniliform, and, under a high power, appear as if constricted in the middle, so as to be nearly divided, while faint longitudinal lines appear to pass from one bead to that opposite to it in the next transverse

line. S. V. nearly rhombic, narrow; but the angle in the middle is, as it were, rounded off, and not well marked as in *N. angularis*. Extremities very acute. Keel central, prominent, with the same distant markings as appear on the F. V., only here they are seen as puncta. Length about 0·003″. (296.)

45. *Nitzschia socialis*, n. sp. This pretty species is remarkable from its occurring, in the prepared material, after boiling with acids, in groups of six, eight, ten, twelve, or more, without any apparent connection between them. One of these is represented in fig. 45.

Form of the S. V. linear lanceolate, narrow; extremities acute. Keel central. Puncta closely set. Valve finely but very distinctly marked with transverse parallel striæ; striæ 30 to 36 in 0·001″. F. V. rectangular. Colour yellowish-brown. Length about 0·0032″. The valves also occur detached; but the groups are very frequent. This form may possibly be a Homæocladia, but it seems quite distinct from any of those figured by Professor Smith. (297.)

46. *Nitzschia insignis*, n. sp. This fine species is not very rare in the deposit, though often fractured, and the F. V. is very seldom seen. The F. V. is shown in fig. 46, the S. V. in fig. 46*.

Form of the F. V. linear, rectangular, with obtusely rounded ends. Puncta distant. Lateral parts transversely striated. Striæ conspicuous, especially on the S. V., where they traverse the whole valve. Length from 0·007″ to 0·015″. Puncta about 6 in 0·001″. Striæ about 30 in 0·001″. Keel on the S. V. not quite central. S. V. slightly bent at the ends, opposite ways, in some individuals; in others perfectly straight.

This species, in length, and also in form, resembles the straighter forms of *N. sigmoidea*, from which the conspicuous striation at once separates it. From *N. Brébissonii* it is distinguished by the aspect of the F. V., which in *N. insignis* is much longer and narrower, and quite straight, besides having a long blank rectangular space in the middle. In *N. Brébissonii* the F. V. is striated across the whole valve, except a narrow raphe, and the valve is sigmoid on this view. It cannot be confounded with *N. scalaris*, having much finer markings, and being a much slenderer form than that species. It evidently belongs, however, to the same group. It is further distinguished from *N. scalaris* by the absence of the rounded swellings out near the ends of the F. V. (298).

I have not yet found this, or either of the two other species of *Nitzschia* here described, in any recent gathering. They are probably all of marine origin.

(All three species occur in the recent gathering above named.)

47. *Eupodiscus sparsus*, n. sp. In my former paper I figured, under the name of *Eupodiscus Ralfsii β*, but doubtfully, a fine disc, which is frequent in the coarser densities of the Glenshira Sand. I pointed out that, although in some points agreeing with *E. Ralfsii*, as I had seen it, (for no description of that species had yet appeared,) it yet differed from it in the absence of the peculiar elongated angular blank spaces, which in *E. Ralfsii* are scattered over the surface. Since then, I have examined many fine specimens of both, as both are frequent in the coarser densities, and I find that *E. Ralfsii* appears almost invariably blue or purple when seen with a low power, such as the two thirds, or even the half, and sometimes even with the quarter or one fifth. These blue discs of *E. Ralfsii* always showed the angular blank spaces. On the other hand, *E. sparsus*, as I call, provisionally, the new disc, is never blue, but always buff-coloured, or brown, or occasionally colourless, even under the low powers. In many specimens, no blanks whatever occur; in some, occasional blanks appear, but look like the effects of injury.

The figure in my former paper gives a very good idea of the general aspect of *E. sparsus*, but I must add, that in that individual, the granules of which the rays are composed are set much closer than is often the case. In this particular a good deal of variation is observed.

On a close inspection of the more sparsely grained discs, I observed a very curious and beautiful structure, which I have found, in great perfection, in the rather small disc represented in fig. 47, which is most accurate.

In this disc, the diameter of which is 0·0019″, there are twelve principal and equidistant rays formed of round dots, not at all closely set. Of such rays, in the common size of the discs, diameter 0·003″ to 0·0035″, there are usually eighteen. Between the twelve principal rays, which meet in the circumference of a small circle, formed round the centre by the terminal dots of these rays, are twelve shorter rays, which stop short, as far from the circumference of the central small circle, as that is from the centre. On each side of these shorter secondary rays are three similarly dotted lines (in the larger discs four such lines), which are not rays, but are strictly parallel to the secondary rays on each side of which they lie, and of course, in each of the twelve primary segments, parallel also to each other.

In consequence of this very peculiar arrangement, it is obvious that the lines, parallel to the secondary rays, cannot reach the centre, if produced, nor can they meet the secondary rays, but in that case would meet the primary rays at a very

acute angle. They stop short, however, of the length of the secondary rays, as these do of the primary, and to about the same extent, each line, as we go from the secondary towards the primary rays, becoming shorter than the preceding one, till the third and last on each side is reduced to four or five dots, and there are often seen, in the larger discs, after the fourth of these parallel lines, one or two dots, indicating the presence of a fifth, for the extension of which no room has been left.

It is evident that so remarkable a structure must amount to a specific, at least, if not to a generic distinction. It will be observed that the successive shortening of the lines, from the centre towards the circumference, produces a good many blank spaces, which, however, are so symmetrical, as not to catch the eye as blanks, as the blanks in *E. Ralfsii* do, which, besides being irregular as to position, are smaller and more numerous. Nevertheless, although I have not yet had time to examine *E. Ralfsii* minutely, I rather think that its structure is, essentially, like that of *E. sparsus*, although in *E. Ralfsii* the dots are both larger and more closely set. Whether this be the only cause of the blue colour I cannot say; but I find that individuals of *E. sparsus*, in which, as already stated, the rays and dots are very close, still retain their brown colour, only darker. It is possible that the blanks in *E. Ralfsii* may prove, when closely examined, to be the result of the structure above described, when the rays and dots are close; yet this does not explain how *E. sparsus* should often occur, both when sparsely and closely marked, without any of the peculiar blanks of *E. Ralfsii*. The individual here figured, probably from its smaller size, and especially from the sparseness of the markings, is colourless; while, as I have stated, *E. sparsus* is usually of a paler or darker brown.

I presume we shall have a description of *E. Ralfsii*, and probably of its varieties, in vol. ii of the 'Synopsis.' In the meantime I venture to direct the attention of observers, both to the very remarkable structure so well seen in fig. 47, and to the differences in colour and other points between *E. sparsus*, and what is generally believed to be *E. Ralfsii*, although I am inclined to believe that both forms possess the same general structure, and the same arrangement of the markings. (299.)*

* On comparing again several discs of both kinds, I find that the arrangement is the same in both, but that in those of *E. Ralfsii*, which appear blue, as most do, the dots are always large and very close, while in *E. sparsus* they are small and further apart. In one specimen, which I have not had time to figure, the dots are very small indeed.

(In the recent gathering above referred to, *E. Ralfsii* is frequent, and I have found its colour, under the ², to vary from purple to dark blue, bright-

48. *Synedra Baculus*, n. sp. This form is not at all rare in the deposit, and I cannot refer it to any of the *Synedræ* in the 'Synopsis,' vol. i. It is certainly not *S. superba*.

Form linear, rather narrow, very nearly of equal width throughout on the S. V.; ends obtuse; F. V. rectangular. The valve is transversely striated. Striæ rather conspicuous, and traversed by faint longitudinal lines. Length from 0·01″ to 0·018″ or even 0·02″. It is represented in fig. 54 (300.)

I have now to mention a few forms, which I do not venture to name, partly from not having yet been able to study them fully, and partly because I have not been able to refer to all the works I wish to consult. One or two of them may probably prove not to be *Diatomaceæ*.

49. *Orthosira* or *Coscinodiscus?* This disc, represented in fig. 48, is frequent in the deposit, and I have not been able to trace any view but that which is figured, or consequently to ascertain whether it be an *Orthosira*, which it may be, or a disc of some other genus, or finally a discoid diaphragm or dissepiment, belonging to an *Orthosira* or some similar form.

Diameter from 0·001″ to 0·0025″. Margin transversely striated. General surface marked with very fine short lines, apparently devoid of any regularity of arrangement. These are very difficult to resolve; but it is easy to see, all over the surface, small distant puncta, scattered sparsely, without arrangement or symmetry. The disc is convex. (301.)

50. *Coscinodiscus* or *Actinocyclus?* This disc is not very rare, but less frequent than the last. The same general remarks apply to it. It will be figured in connection with our communication on the Clyde forms, want of space having compelled its omission here.

Diameter, as in the preceding case, from 0·001″ to 0·0025″, but often as much as 0·003″. Colour brown. The whole

blue, pale blue, greenish blue, green, and yellowish green; and, in a few cases brown, passing from brown to purple. I have also seen one or two individuals of a buff colour, exhibiting the angular blanks which characterise the blue ones. On the other hand, *E. sparsus* is always brown, buff-coloured or colourless. When the two forms occur together, *E. sparsus* is seen to be in general much larger and much flatter, and it does not exhibit the angular blanks, which, as I suspected, are the results of the arrangement I have described, in *E. Ralfsii*, where the rays and granules are both closely set, and the granules larger. The largest examples of *E. sparsus* are in general the least coloured, probably because the granules are even less closely set than in the smaller discs, and the angular blanks are entirely absent. Whether these differences, producing so great a difference of aspect, be specific or not, I must leave to others to decide. At present, I am at a loss to account for the fact, that two discs may occur, of the same size, and both buff-coloured. one of which shows the angular blanks, while the other exhibits no blanks whatever.)

surface is marked with very fine granulations, among which may be observed faint rays, especially towards the margin, which is transversely striated, indicating a regular symmetrical structure. I have not been able to determine the genus; but as it seems to be cellular, I think it likely to be a *Coscinodiscus*. There are also two or three other discs which I am unable to name; but I have not had time to obtain figures of them. (302.)

51. *Campylodiscus*. (?) This form, represented in fig. 50, has occurred to me several times. At first I took it for a *Coscinodiscus*, but on closer inspection it is found not to be truly orbicular, and rather to resemble a *Campylodiscus*. It does not agree with any of the species in Smith's 'Synopsis;' but as it may be an immature form, I leave it for further investigation.

Form quasi-orbicular, flattened a little at one side, and projecting a little at the opposite part. The markings consist of large sparse dots, arranged in a way which is partly radiate, partly in parallel lines, somewhat like *Eupodiscus sparsus* above described. There is some appearance among these lines of a broad rectangular cross, but not distinctly brought out. No central space, the dotted lines meeting in the centre. It is possible that it may, after all, be a *Coscinodiscus*. (303.)

(This form occurs, not unfrequently, in the recent gathering of which I have spoken above. It is sometimes, as in the figure, not exactly round, but it also occurs perfectly orbicular. I hope to be able to study it more fully. It has some resemblance to *Eupodiscus tenellus*, Bréb., but I cannot see in it the characteristic protuberance of *Eupodiscus*.)

52. *Amphiprora*. (?) This little form is frequent in the deposit, and I have conjectured it to be an *Amphiprora* from its resemblance in form and general structure to that which I have above described as *A. recta*. It is represented in fig. 51.

Form nearly rectangular, narrow; the ends rounded, obtuse. Frustule slightly constricted in the middle. The whole surface, except a narrow space in the middle, widening a little at the ends, is marked by transverse striæ, which are conspicuous, radiate, and inclined, about 25 to 0·001″. There is, as in *A. recta*, an appearance of a central nodule visible on each valve, round which the striæ seem to radiate. Length from 0·0015″ to 0·003′.

At first sight this form, as well as *A. recta*, might be supposed to be the F. V. of a *Navicula* or *Pinnularia*. But among all the forms of these genera in the deposit, there is not one which agrees with this in its characters. Besides,

the striation nearly covers the whole frustule on the F. V., which we never find in *Navicula* or *Pinnularia*. Moreover, although the form is frequent, the S. V. which, as in *A. vitrea*, would much resemble a *Navicula*, does not occur, or at least I have not been able to find it, although I can trace both the F. V. and the S. V. in all the species of *Navicula* and *Pinnularia* which I have been able to distinguish. For these reasons I suspect it to be of a different genus, probably an *Amphiprora;* but as this is doubtful, I figure it as a form to be further examined. (304.)

53. *Disc.* This form, represented in fig. 52, is in all probability not *Diatomaceous*, but one of the *Polycystineæ*. It is a very beautiful object, and is made up of large hexagonal cells, the disc having a raised border or margin of considerable breadth, crossed by what appear like rings projecting on the circumference. Diameter about 0·002″. Many of the cells, which otherwise resemble those of *Eupodiscus Argus*, or of *Triceratium Favus*, have a punctum in their centre.

Not being familiar with the *Polycystineæ*, I figure this disc in the hope that some one who is familiar with them will be able to say whether it be one or not. It is at all events a fine object, and is very scarce indeed in the deposit. I observe a few very similar discs in an earth sent to me by Professor Bailey, marked, Bermuda tripoli, locality doubtful. (305.)

54. *Oval form*, fig. 53. When I observed this curious form with a low power, it seemed to resemble an *Amphora;* but on closer examination this resemblance disappeared, and I found myself unable to refer it to any genus known to me. Indeed, I have considerable doubts whether it be *Diatomaceous*, and suspect that it may prove, like the preceding, to belong to the family of the *Polycystineæ*. The specimen is unique, up to this time, in the deposit.

General form oval. The upper end seems to show an acute interior point, from which the external covering has been broken away, so as to expose it. At the lower end it appears to terminate in a cylindrical neck, which is truncated near to the body. The surface is marked by concentric lines of large and somewhat distant dots, these lines being arranged in pairs, the two of each pair rather close, but the interval between two pairs much wider. Of these pairs of lines, four are visible. Length about 0·001″. On the whole, it seems to be more like one of the *Polycystineæ* than a Diatom. (306.)

Such is a brief account of the forms I have found in the Glenshira Sand, in addition to those formerly described, and

so far as I have been able to complete the examination of them. But several forms still remain, which must be reserved for more full examination.

It will be seen that, including the additional list of previously described forms, and those now first described, the number of species already found in this remarkable deposit, which in my former Paper extended to 234, now amounts to 304; a number, so far as I am aware, very far surpassing anything elsewhere observed, and nearly three times as great as that of the species in the estuarial mud of the Thames, as described by Mr. Roper, which is almost the only deposit, rich both in fresh-water and marine forms, hitherto fully described. The deposits and gatherings described by Ehrenberg have generally been either marine or fresh-water alone. I have shown the probable cause of the mixture of marine and fresh-water forms, but I cannot suggest any satisfactory explanation of the unusual accumulation of species, and can only conjecture that the deposit was formed during a very long period, in the course of which waters from different quarters may have at different times been carried to the spot.

But the Glenshira sand or mud is even more remarkable for the large proportion of new or undescribed forms, than for the aggregate number of species. In this and the former part of this communication, I have described and figured upwards of sixty forms, all undescribed before, so far as my knowledge extended. This is exclusive of several, which are probably varieties of known forms, as well as of eight or ten which I have elsewhere figured as fresh-water species, found by me in recent gatherings, and either new to science or new as British forms, which also occur in this sand, and several of which I first observed in it. It is also exclusive of a good many new forms observed also elsewhere by other naturalists.

Of the sixty forms just alluded to as new, only a very small number have as yet occurred elsewhere, although most of them are frequent in our deposit. From this I conclude that a large number of unknown forms will still repay the observer who looks for them, especially among marine species. (This conclusion is confirmed by the recent gathering above mentioned, in which I find, not only about 40 of the new Glenshira forms, but a number of species entirely new, of which I gave a short preliminary notice to the Botanical Section at Cheltenham.) A very extensive acquaintance with our fresh-water Diatoms, of which I have minutely searched gatherings from not less—probably many more—than 500 British localities, enables me to say that new forms now occur

but seldom. This is strongly in contrast to the results here described, where one deposit, in great part of marine origin, has yielded more than sixty new forms, the great majority of which have not yet been found elsewhere.

This leads me to observe, that while some dislike the labour of searching for forms in such complex mixtures as the deposit before us, I cannot help thinking that it is worth while to undergo this labour. Had we waited until the most curious of these forms should have occurred in a comparatively unmixed or pure state, many years must have passed before they became known. And although we cannot, for example, make sure of finding in every slide specimens of such remarkable forms as *Amphora obtusa* or *Amphora Grevilliana*, and the others of that singular group, yet, to obtain a knowledge of such a group, we ought not to grudge the trouble of mounting a few extra slides. The Glenshira Sand, even when purified as much as possible, and sorted into densities, is indeed loaded with mica in the coarser, and a very complex mixture of forms and mica in the finer densities. But the results speak for themselves, and I am very far from regretting the time and labour I have devoted to the investigation.

In conclusion, I would mention that the Glenshira Sand will supply observers not only with the new forms, except, perhaps, two or three that are very scarce, but with fine specimens of many known forms which are not always easily procured elsewhere. Of these I may name *Amphitetras antediluviana*, the strongly emarginate variety being frequent, the square one less so; *Stauroneis pulchella*, of the largest size, extending to 0·01″ or more, and varying much in form; (this is *Stauroptera aspera* of Ehrenberg;) *Coscinodiscus radiatus*, fine, varying much in the size and aspect of the cells, and possibly including more than one species. *Coscinodiscus concinnus*, mentioned in the 'Synopsis,' vol. ii; *Navicula convexa*, very fine and large; *N. Jenneri*, extending to 0·008″ or more in length; *Pinnularia megaloptera*, Ehr., of which *P. lata*, Sm., is most probably a short variety. This form occurs so long as 0·006, but more generally 0·004 to 0·005. It is, however, rather scarce. *Epithemia Hyndmanni*, very fine and large; *Coscinodiscus excentricus*; *Eupodiscus crassus*; *Campylodiscus Hodgsonii*, this is rather scarce; *Surirella fastuosa*, large and fine, sometimes very large and constricted in the middle, in which case it much resembles *S. lata*, and, it is possible, may pass into that form. *Synedra superba*; *Nitzschia bilobata*, rather scarce. *Amphiprora vitrea*, very fine; *Amphiprora elegans*, sometimes very large. *Na-*

vicula Smithii (olim *elliptica*, Sm.), very fine. *Himantidium majus*, large. All these occur, with some commoner forms, in the coarser densities, along with the larger of the new forms.

I shall be glad to supply observers with the Glenshira Sand in its natural state; and would recommend them, after it has been boiled in acid, to separate it into densities in the way described by Mr. Okeden. The coarsest portions in which any forms occur, contain so few as to be worthless. The next densities contain the forms above enumerated, as well as the larger among the new forms, with others; and the finer densities contain all the middle-sized and small forms. When well prepared, the entire *Amphora Grevilliana*, for example, is by no means rare in the coarser density, where it is accompanied by *A. Arcus, Campylodiscus simulans, Navicula maxima, N. formosa, N. latissima, Eupodiscus sparsus, E. Ralfsii, &c., &c.*

P.S.—I find I have omitted to mention two species, which are admitted in vol. ii of the 'Synopsis,' as British forms, and which occur in this deposit. These are *Navicula Lyra*, Ehr., and *N. retusa*, Bréb., both marine forms.

I must take this opportunity of expressing my obligations to Mr. West for the great pains he has bestowed on the engraving of the numerous figures above described.

A MICROMETER OBJECT-FINDER. By R. J. FARRANTS, Esq.

(Read April 30th, 1856.)

A SURE and ready method of determining the position of a microscopic object on the glass slide which contains it, so that it may be registered, and the object be brought into the field of view of the microscope, at any time and with any instrument, is still a desideratum with microscopic observers. Ingenious suggestions have indeed been offered, from time to time, with a view to supply this want; but that none of them have fulfilled the requirements may be inferred from the fact that no one of them has obtained general acceptance. I do not doubt that an object may be found, if its place on the glass slide has been accurately registered, with any of the "Finders" at present before the public; still, though the result may be sure, with none of them is the method of determining the position of the object, in the first instance, of ready application.

The plan of Mr. E. G. Wright, of Hereford, published in the 'Quart. Journ. of Micr. Science,' vol. i, p. 301, consists in fixing to or engraving upon the stage of the microscope two scales at right angles to each other, and reading off from

these scales the numbers against the end of the glass slip, and the lower edge of the object-plate, when the object is in the field. This plan may be efficient, but is of very limited applicability, being useful, even to the person who adopts it, only with the particular instrument with which the position of the object has been registered.

Other methods more generally applicable have not yet been very generally applied. It is therefore not unreasonable to presume that all such are deficient in some quality essential to their utility. It appears to me that the deficiency is their not affording ready means of determining the position of an object in the first instance. With most of them it is necessary that the "finder" should be applied to the stage, and be accurately centred before any use can be made of its scales. This is the case with the "Universal Indicator" of Mr. J. W. Bailey, described in the 'Quart. Journ. of Micr. Science,' vol. iv, p. 55, and with the "Finder" of Mr. T. E. Amyot, described in the same work, vol. iv, p. 151. On the plan of Mr. E. G. Wright, also, it is necessary to "adjust the moveable stage exactly square," before the scales are of any use. Now the necessity of observing these conditions as preliminaries to the use of the finder, must frequently prevent its being employed, and that too in cases where the want of it is most felt. It must often happen that an observer in examining a glass slide meets with some remarkable object, a frustule or valve of *Diatomaceæ*, for instance, a peculiar crystal, or some particular cell occurring either in vegetable or animal structure, which he would like to examine more attentively at another time; but not expecting, and therefore not having provided for his having occasion to register the position of any object, he is not able to do so, or at least, as the first step, before he can adjust the stage and apply the scales, he must lose the object whose position he desires to register, chiefly because of the difficulty of finding it; then, after the necessary adjustments have been made, the object must again be sought for. In practice, no doubt, the observer frequently concludes that this tedious operation may as well be deferred until he shall want the object for further examination, and so the registry is not made at all. In using the finder of Mr. Tyrrell (see 'Quart. Journ. of Mic. Science,' vol. i, p. 234), it is true that there are no preliminary adjustments to be made, yet with it also the object must be lost in removing the glass from the stage to place it in the finder, and must be again found before its position can be registered.

The terms latitude and longitude have been already made use of in reference to the place of a microscopical object on a

glass slide. The convenience and aptness of the terms are a sufficient reason for continuing to employ them.

Latitude refers to the position of an object with respect to the width of the glass. Longitude refers to its position with reference to the length of the glass. Latitude therefore will be determined by a line parallel to the sides of the slide which would pass through the object, and the distance of such line from one or other of the sides of the slide, expressed in terms of a scale that has been determined upon, will denote the latitude of the object. The distance from one of the ends of the slip of a line parallel thereto, expressed in like manner, will be the longitude. Latitude, then, will be measured by horizontal lines, and longitude by vertical ones.

Now, if the latitude of an object can be determined with precision, and if the line corresponding thereto can with accuracy be made to coincide with the transverse diameter of the field of view, the object itself may be brought into view by simply moving the glass slide along the stage.

The ledge at the bottom of the object-plate, against which the slide rests when the body of the microscope is in an inclined position, is a line from which the latitude may be conveniently estimated, for as the lower edge of the slide rests against this ledge, the distance from it to the line on which the object is situate is the latitude required. For determining the longitude, it is convenient that the object-plate be furnished with a stop on one side (preferably the left), against which the glass slide may be made to abut. This may consist of a narrow slip of brass, half an inch in length, projecting a little above the surface of the plate, and having two pins on its under surface to drop into two small holes drilled in the object-plate to receive them. Such a stop is applied and removed in an instant, and affords a line from which the longitude may be measured, as certainly and as conveniently as latitude is measured from the ledge on which the slide rests.

The scales to be used in determining the position of an object are ruled on a slip of glass, or other material, of the size ordinarily used for microscopic purposes, viz., 3 inches by 1 inch. Let the centre inch be ruled with horizontal and vertical lines, at regular distances apart, say 50 to the inch; the superficial square inch will thus be covered with small squares: this done, the observer is supplied with the means of accurately determining the position of any object. These scales are available at any moment, no preliminary arrangements are necessary before they can be used, and the readings being made under the microscope may be made with greater

exactness than is possible in reading scales applied to the stage which can be seen only with the eye, at most aided by a lens.

I have had ample experience of the efficiency and utility of the method of registration, the details of which are given below, having used it for several years, though with very imperfect scales; indeed, they were nothing more than lines 25 to the inch, scratched with a writing diamond on the centre inch of an ordinary glass slip, the vertical and horizontal lines being on different glasses, or on different sides of the same glass. These scales afforded the means of registering and finding any object with the $\frac{2}{3}$-inch object-glass, but the divisions were neither sufficiently regular nor minute enough to be used with advantage with an object-glass of higher power. Of late, through the kindness of Mr. G. Jackson (to whom I am much indebted for the trouble he has taken in the matter, and for which I pray him to accept my best thanks), I have been enabled to make trial of different scales, ruled with that precision and neatness which are so well known to and appreciated by all who make use of the micrometers ruled by that gentleman. These scales, and the mode of using them, I will now describe as briefly and intelligibly as I can.

Since objects are usually placed as nearly as possible in the centre of the slide on which they are mounted, it rarely happens that any specimen is found within an $\frac{1}{8}$th of an inch of either edge of the slide, and the $\frac{3}{4}$ths of an inch square in the middle of the slide is the space within which most objects will be found; and since nothing is gained by having more lines ruled than are actually wanted, while the counting is thereby rendered more troublesome, it has been thought better not to extend the ruling over a greater surface than $\frac{3}{4}$ths of an inch square.

The scales ruled by Mr. Jackson, which I now use, and would recommend, are formed by horizontal and vertical lines, ruled on the same surface of the glass, at a distance of $\frac{1}{100}$th of an inch apart; every fifth line is thicker, and consequently more conspicuous than the rest, besides, the centres of both series are distinguished by double lines; and by these means the counting is greatly facilitated: there are in each series 72 lines (the centres being double), which include 70 spaces, of which 35 lie on each side of the central double line in each direction; a space $\frac{7}{10}$ (·7) of an inch square in the middle of a glass slip is thus covered with a series of squares, 4900 in number, the sides of which are $\frac{1}{100}$th of an inch linear, and the area $\frac{1}{10000}$th of a square inch; of these

the field of view with ¼-inch object-glass will include nearly 4; or if any square be brought to the centre of the field there will also be visible the half of 4 squares, one on each side of the central one, and nearly a quarter of 4 others, one at each corner of that which occupies the centre of the field.

The mode of using these scales is as follows:—If, for example, it be wished to register the latitude of an object in the field of the microscope (the lower edge of the glass slide, it is presumed, resting against the ledge of the object-plate), bring the object as nearly as possible to the centre of the field; then remove the slide from the stage, and put in its place the ruled slip; observe which line coincides with the transverse diameter of the field, that is, with the position of the object, then count (upwards, as it appears in the microscope) from this line to the end of the series: suppose the 45th line is that which corresponds with the position of the object, then 45 will denote the latitude of that object, that is, its distance from the lower edge of the slide. At any future time, and with any instrument, this object can be readily found; to effect this, place the ruled slip on the object-plate, the lower edge resting evenly against the ledge, then bring the upper line (as it appears) of the horizontal series into view, and count 45 from it (this is easily and quickly done by taking advantage of the conspicuousness of every fifth line), make that line coincide with the transverse diameter of the field of view; the ruled slip may then be removed from the stage, and the slide containing the object be put in its place; the object sought now lies somewhere on the line which corresponds with the transverse diameter of the field, and if the glass be slowly moved across the stage will soon come into view.

It is generally sufficient to determine with exactness the latitude of an object: if, however, it be thought desirable to register the longitude also, this may be done by proceeding in a manner altogether analogous to that just described, the only difference being that it is the position of a vertical line passing through the object that is now to be ascertained, and its distance from the end of the slide. Now it is that the lateral stop will be found convenient; it is not, however, indispensable, since a temporary expedient may be made to supply its place, or the lateral edge of the object-plate may be taken as the line from which the longitude is measured; in that case, the end of the slide containing the object must be brought even with the edge of the object-plate, and the object being brought into view by means of the lateral stage

movements, the slide is then to be removed, and the ruled slip put in the same position, that is, with its end abutting against the lateral stop, or exactly even with the side of the object-plate, as the case may be; the vertical line coinciding with the vertical diameter of the field of view will then correspond with a vertical line on which the object is situate; suppose this line is the 40th (from the right of the series, as seen in the microscope), the number 40 will then express the longitude, and will denote its distance from the left end of the slide. It is scarcely necessary to remark, that the slide, as well as the ruled slip, must always be placed on the stage in the same way, that is, with the same edge always uppermost: to ensure this it is well to adhere constantly to some plan; for instance, the rule may be always to keep the label on the slide to the right hand.

If the longitude has been registered as well as the latitude, the object will be found by proceeding as follows:—First find the latitude by bringing the horizontal line on the ruled slip denoted by the number into the centre of the field; then, taking care that the end of the slip is close up to the lateral stop, or even with the edge of the object-plate, bring into the centre of the field the vertical line denoted by the register; the ruled slip may then be removed from the stage, and the slide with the object being put in its place, the object will be in the field; and if the observations and manipulation have been made with correctness, will be at or near the centre.

If the eye-piece have an indicator it will be convenient to bring it into the field, and to move the object to its point; the line on the ruled slip which corresponds with it may then be ascertained with the greatest exactness. If there be not an indicator, still, as the eye-glasses will seldom be so clear as not to have some mark or speck of dust, any such accidental mark that may be observed may be made to serve the same purpose as the point of the indicator.

An object once found need never be lost till its position has been determined and registered; for without moving the stage or object-plate, the slide with the object may be taken off the stage, and the ruled slip be put in its place: this may be moved upwards by the hands while the horizontal lines are being counted, and to one side (the right) to enable the observer to count the vertical ones; these being duly noted the ruled slip may be taken away, and the glass with the object be again put on the stage. If no movement of the stage have been made the object should be seen in the same

position as at first; the accuracy of the register can thus be at once ascertained, or any error be detected and corrected.

As may be expected, it in fact seldom happens that any line on the ruled slip will exactly coincide with the position of an object, which is more frequently found to lie in the interval between two lines. It is better therefore to make the register refer to the spaces instead of to the lines. The number 45 then, for example, denoting the latitude of an object, will indicate that its position is in the space expressed by that number.

To register the position of an object it is only necessary to put down in figures the numbers which denote the spaces observed; for instance, the position of the object just supposed to have been ascertained would be registered thus:

Lat. 45. Long. 40.

It will save trouble if an arbitrary significance be given to position. Thus it may be determined that the first number shall always refer to latitude, in which case the register might stand thus:

$\frac{45}{40}$ or 45 : 40.

I prefer the latter, because the figures better admit of any appendix which may be used to modify their significance. For example, the object whose position is found to correspond with the square denoted by 45 : 40 may lie nearer to the upper line than to the lower one, or the contrary; now this may be clearly indicated by a short line added to the figures. Thus, if the object lie nearer the upper line, that may be indicated by a short line above the figures, $\overline{45}$; if the object lie nearer the lower line the fact may be indicated by a line below the figures thus, $\underline{45}$. Similarly the greater proximity of an object to the vertical line on the right or left of it may be shown by a short line before or after the figures, as |40 40|, the meaning of the line so placed is obvious. Again, if the position of the object coincide exactly with a line on the ruled slip, that may be denoted by drawing a line through the figures thus, $\not{45}$; if then the position of any object be registered thus, $\not{45}$: |40, it will signify that its latitude corresponds with the 45th horizontal line of the ruled slip, while its longitude corresponds with the 40th vertical space, but that it is nearer to the line on the left side. In this way then four positions in respect of each square may be clearly pointed out, and the area of each square being the $\frac{1}{1000}$th of a square inch, it follows that the place of an object can be assigned with an exactness nearly approaching the $\frac{1}{4000}$th of a square inch. As the field of view with the $\frac{1}{4}$-inch object-glass with

the first eye-piece shows nearly the whole of four squares, or the whole of one square, and a part greater or less of eight others, it is scarcely possible with only moderate care that an observation should be so inaccurate as that an object whose position has been registered should not be brought into the field of that glass. If sufficient attention be paid in ascertaining and recording the position of the object, it may almost as surely be placed in the field of an $\frac{1}{8}$th or a $\frac{1}{12}$th.

In registering the position of an object as determined by these scales, a somewhat different plan from that already described may be and is adopted by some. Thus, taking advantage of the clear determination of the centres of both scales, with a view to reduce the counting to a minimum, the reckoning may proceed from the centre in all directions. The horizontal lines may be counted from the centre upwards and downwards for latitude; the vertical ones too may be counted from the centre right and left for longitude. On this plan the latitude of an object registered on the previous plan as 45, would be registered 10 below the centre. If it were 25 on the first plan, according to this one it would be 10 above the central line; this line being taken to represent the equator, the terms north and south may be used with reference to it. In like manner east and west may be used in reference to longitude, to signify the position of a vertical line right or left of the central one.

The manner of registering the observations will make no difference in the result, and is a mere matter of detail which every individual may settle for himself. The only important things are that both the observation and registration be accurate.

Report *of the* Committee *appointed by the* Microscopical Society *for the purpose of ascertaining the most convenient form of* Finder *for indicating the position of* Objects *under the* Microscope.

(Read June 25th, 1856.)

An apparatus for registering the position of any number of minute objects contained in a slide, and for readily finding any one of them, either under the same microscope, or any other, has for some time been a desideratum with observers; and various plans have been proposed. The Council of the Microscopical Society have therefore thought fit to appoint a Committee to consider the subject, and to suggest some means

of accomplishing the object, of such a simple and inexpensive character as would merit universal adoption.

The Committee have held three meetings, besides having had communications by letter, and they now proceed to lay before the Society the result of their deliberations.

They consider that a finder, in order to be universally adopted, should possess the following properties:

1st. It should be applicable to any microscope, whether furnished with stage-movements or not; and it should not preclude the use of these movements.

2d. It should not require fresh labels to be placed on the slides, or any mark or index to be made on them.

3d. It should not be necessary to remove the slide or finder for the registering or finding of every separate object.

4th. The divisions on the index should be easily read.

5th. It should allow the microscope to be used in the inclined position; and—

6th. It should be cheap, and simple enough to be constructed by any one possessing a moderate amount of mechanical skill.

In the plans which they recommend for carrying out these requirements, the Committee lay no claim to originality; for they have merely selected materials from what has been already proposed, and arranged them in a modified form. They are therefore free from the prejudice which an inventor would naturally feel in favour of his own ideas.

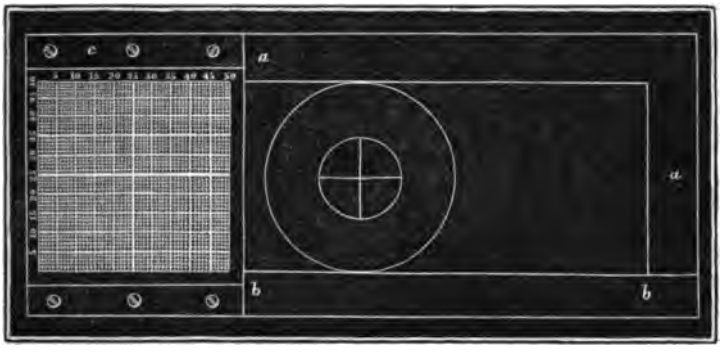
Whatever modification an individual may contrive for his own convenience, in the form of the finder, the same standard of measurement should be adopted; and the measurements or distances of objects must be taken relatively to the same fixed point. This point should by no means have reference to any part of the microscope (which would be fatal to a *universal* system), but should be considered as a point *in the slide itself*, upon which the object is mounted.

The slides recommended by the Microscopical Society (three inches by one) are now so generally used that it is not worth while to propose a method of meeting exceptional cases; therefore the above starting point may, under all circumstances, be represented by the intersection of two crossed lines taken as perpendiculars, one and a half inch from one end of the slide, and half an inch from one side. As it would be difficult and troublesome to rule this cross on every slide, it is preferable to have one plain slide as a standard, with the cross occupying the position above named. The measured distance being taken strictly from *one* end and *one* side, the corner common to them should be marked with an

arrow-head, in order to avoid the error that would be occasioned if the glass were not cut of the *exact* dimensions, and the wrong end were used in the adjustment. These lines should be ruled with a diamond point, filled with plumbago, and covered with thin glass.

It now remains to explain the application of this fundamental starting point for rendering all forms of finders universal.

First, with respect to microscopes without stage movements. Fig. 1 *a, a,* is a carrier, made either of metal or



wood, whose outside dimensions are three and a quarter inches long by one and a half wide. Along the lower margin is fixed a raised edge, one quarter of an inch broad, for the slide to rest against. There is a hole one inch in diameter in the carrier, the distance of whose centre is one and a half inch from the right-hand end.

On the left-hand end is fastened to the raised edge, or slip, a piece of brass, *c,* one and a quarter inch square, having a sufficient space beneath it to allow the thickest slide to pass under, and abut against a stop at the end; by this means an inconvenient length of the carrier is avoided. The upper plane surface of this plate contains the index, which may be printed on enamelled paper, and contains one square inch, divided by lines at distances of one fiftieth of an inch, crossing each other at right angles. The two lines which cross the centre each way are considerably thicker than the rest, and are numbered 25 (being half the number of the divisions); and the intersection of these is always the starting point for making the adjustments. Every fifth line from this is rather less in thickness, and is numbered at the side; the intermediate ones being as fine as may be convenient for

distinct observation. The exact position in which the paper index is pasted on is not of material consequence, provided it lies square with the carrier.

The method of using this finder is as follows:—First take the *standard*, and place its marked end against the abutment under the index-plate of the carrier, and see that it rests upon the bottom ledge. Then place them both together under the microscope, with an object-glass attached. By sliding up or down the vertical moving straight edge (with which every plain stage should be fitted), and by shifting the carrier sideways against this edge, bring the cross into the centre of the field. A moveable index, or hand, is now made to point to the centre, or crossing of the thick lines on the index-plate, and there fixed fast. This hand, or pointer, is simply a thin, flat piece of brass, turned round like a hook or staple, having the longest limb ending in a point, and the shortest slotted, to be clamped to the under side of the fixed stage-plate, by means of a milled-headed screw passing through the slot.

The longitudinal adjustment of the pointer is performed by thrusting it endways, and the transverse by turning it sideways. Now look through the microscope again, to ascertain if the cross on the standard is still in the centre of the field, and coincident with the adjustment of the pointer. If so, remove the standard, and replace it by the slide containing objects whose position is either to be registered or found. If the pointer is not in the way when not in use, it may remain fixed; and readjustment by the standard will be unnecessary except for occasional verification. It is now evident that the centre of the field is represented by the pointer on the index-plate at an invariable distance; therefore, if the carrier be always moved in straight lines at right angles, the pointer will indicate the latitude and longitude of the object under the microscope at the time.

Although the centre of the slide is taken as the most convenient point for adjusting the index, it is best to consider the lower horizontal line on the index-plate as the equator, and the left-hand perpendicular one as the first meridian; by which means all the latitudes will be north, and the longitudes east; and, if the first figure be invariably appropriated to the latitude, the registration will be very simple. Should it be necessary to register smaller quantities than the fiftieth of an inch, the amount may be estimated with sufficient accuracy, and added as a decimal figure; and this will be found much easier in practice than the reading of very fine divisions.

In registering a large cabinet of *Diatomaceæ, Desmidieæ,* &c., it will only be necessary to number the slides, and to enter on a printed list of these objects, the number, latitude, and longitude where they may be found. By these means any specimen may be placed under the microscope in less than a minute.

The finder may be applied to microscopes having stage-movements by merely laying the carrier against the horizontal straight edge on the top plate; and, after fixing the rotary plate (if there be one) by a pin passed into a hole drilled through this plate and the next, the adjustments already described may be made, using the milled heads for the purpose. In those microscopes which have the longitudinal and perpendicular sliding plates divided into fiftieths of an inch, the principle of a universal finder may be applied in a very simple manner. The rotary movement being fixed in the above mode, there must be a stop, consisting of a strip of plate brass, with one end turned up, to form an abutment, and the other slotted and passing under the head of a screw in the top plate, so as to move with sufficient friction to retain its position.

The graduated scales should then both be set to read 25, and the standard placed on the stage. Then bring the cross into the centre of the field by shifting the stop laterally, and moving the top plate, or straight edge, perpendicularly, taking care to keep the standard hard against both its bearings. When this has been effected the standard may be removed, and, if any slide be placed in the same position against the stop and ledge, the objects in it may be registered and found by means of the graduated scales, freely using the stage-movements for the purpose, but being careful not to shift the top plate or sliding stop.

This form of finder is to be recommended where rectilinear stage-movements exist, on account of its simplicity. A substitute for the graduated scales may be obtained by cutting off the edges from two of the square index-plates here described, and cementing them in the most convenient situations.

Another method would be to fasten one of the entire square scales on the top plate of the microscope; but this would involve the necessity of a pointer, as in the case of using the carrier.

Having now described a finder that can be used either with the most simple form of microscope, as a temporary addition to the ordinary stage-movements, or as permanently incorporated with them, we by no means desire arbitrarily

to assert that these plans are the best that can be devised. The subject is still open to improvement; but, whatever modification is adopted, in performance of our duty we strongly urge the necessity of basing them all upon *one similar standard of measurement*, taken from a *fixed point on the object-slide itself*. If this be done, objects registered by one observer may be found by another, though each may use a finder of a different form; the difference affecting merely convenience in using.

There is one observation arising from this subject, although not strictly a portion of it, which the Committee wish to make. If, by reason of defective workmanship, or errors caused by the use of adapters, different object-glasses are not in the same line of centre, a readjustment by means of the standard will be required on changing the objective. We therefore call attention to the great convenience it would be to all users of the microscope if every maker would adopt the same pattern for a screw, a proper steel gauge being provided for the purpose. At present it not unfrequently happens, on applying another object-glass to a microscope, that it has to be built upon a system of three or four adapters, to the manifest detriment of its performance. If all our principal makers will acquiesce in this, we shall be most happy to give our assistance in establishing the best form of screw.

As our endeavour has principally been to determine the means by which a uniform system of registration may be obtained, we have not thought it necessary to make any critical inquiry as to the respective merits or defects of the plans already published; we have borrowed freely from them; and we have also received valuable practical suggestions from Professor Quekett and Mr. Hislop, for which we here tender our thanks.

(Signed) GEORGE JACKSON.
CHAS. BROOKE.
F. H. WENHAM.

BRIEF REMARKS *upon* CELL-GROWTH *in the* BRYONIA DIOICA. By NORRIS F. DAVEY, Esq., M.R.C.S. Eng.

(Read June 25th, 1856.)

HAVING been much interested by Mr. Wenham's recently published views with regard to the development of vegetable cells, I felt a strong desire to repeat his observations. After having seen all that he describes in the *Anacharis*, it occurred

to me, that if a plant of very rapid growth were subjected to examination without detaching the embryonic parts from the main stem, the actual transition of protoplasm into cells might be observed. As I have not been disappointed in this hope, I am desirous of communicating my success to the Microscopical Society.

The plant which, for various reasons, I selected for examination is the common Bryony; it is peculiarly well suited to the purpose, as it is hardy, of rapid growth, and its long, slender shoots are easily brought under the microscope. The method of examination I adopt is as follows:—a plant of Bryony being potted, and sufficient time having elapsed for recovery from the shock of removal, one of the strongest shoots is deprived of its leaves, &c., near the apex, until the soft plastic masses of embryonic parts are brought into view; these are washed with pure water to remove fragments, and placed in a compressor in water under the microscope.

In consequence of the tapering form of the apex of the shoot, I have found some difficulty in compressing the soft parts without crushing the thicker stem beyond; I have therefore devised a form of compressor for the purpose, which answers exceedingly well. It consists of a slip of glass, 3 inches by 1, and a thinner one, 3 inches by $\frac{3}{4}$; these are hinged together at their margins with tape and solution of shell-lac in naphtha; the tape is thus fastened firmly to the glasses, and rendered waterproof.

Into the acute angle formed by these glasses when opened a little, the prepared shoot is introduced, with plenty of water; the pressure is applied by bringing down the bars of the stage clip upon the upper glass. In this manner I have easily succeeded in applying moderate pressure to the extreme apex, without crushing the stem through which it derives its nourishment.

I will now proceed to state what I have observed, premising that I do not profess in this brief communication to touch upon all the points connected with cell-formation, nor to attack or defend theories, but simply to state the fact that I have seen the actual transition of soft plastic masses into a cellular condition, and to describe what appearances were presented during that transition.

After the young shoot has been in the compressor for a short time, the semitransparent, granular mass, which is the most recently formed, is seen to augment gradually in bulk, and from being nearly colourless or of a yellowish colour, assumes near its centre a decided yellow-green. The edges of this mass, when subjected to slight pressure, are seen to

consist of an elastic material, full of granules, but otherwise destitute of structure; after a short period, this granular mass presents a spongy appearance, numerous irregular cavities being developed in it. Some of the larger cavities exceed the smaller ones in the proportion of 3 to 1. After a variable period, the cavities become better defined, and the substance intervening between them appears thinner. The larger cells are then subdivided by septa, apparently of the same plastic material; these septa are formed at one side of the cavity, and stretch gradually across it, and when they have reached the opposite side, coalesce with it, and thus divide the cavity into two. All this has been made out by Mr. Wenham, from the examination of the parts in successive stages; and I have actually seen it occur in the bryony.

As soon as the embryo leaf of the Bryony has become so far developed that its cells have assumed a somewhat regular form, and its central parts have acquired a greenish colour, small, transparent, rounded projections (embryo hairs) make their appearance at its margin; these are faintly granular, rapidly increase in length, and soon develop a cavity or cavities in their interior; after their cavities have increased in size, and their walls have become more marked, they commonly assume a kidney-like form, and a septum of protoplasm passes across to the opposite side and effects division of the cell; the hair is thus divided into cavities of tolerable regularity. After these cells have become more shaped, the growth of the hair is continued in the direction of its length by globular masses of protoplasm which form at its extremity; these, in the case of hairs upon the leaves and stalks, generally elongate, and sometimes further subdivide, the result being a pointed hair of six or seven joints. In the case of the flowers and flower-stalks, the hairs do not attain the same form, but mass after mass of protoplasm is added to the extremity; these retain more or less of their globular shape, and form empty spaces within them of the most irregular form and number; some of the terminal masses have no cavities, but, when the flower is mature, shrivel up without further development. I therefore believe, that as the flowers attain their growth, their hairs become abortive, and that the latter are not intended to reach the same dimensions and form as on the leaves and main stems. The utmost irregularity prevails as to the number of joints, cavities, &c., in these hairs from flowering parts; some are even bifid: there is, moreover, far greater difficulty in actually watching their changes, as their growth is comparatively slow in their latter stages.

It is worthy of remark, that protoplasm is not only the substance from which normal parts are formed, but it is also the material by which injuries are repaired. If a portion of an embryonic mass be cut partially off, fresh protoplasm is seen to exude to restore the part, cavities form in it, &c., while the nearly detached part loses its vitality and collapses.

With respect to the manner in which protoplasm reaches the distal cells of a hair or a mass, it seems to me to be most probable that it occurs by endosmosis from cell to cell; that endosmosis takes place readily through the wall of an immature cell is certain, for some of the clubbed hairs can be seen to fill and burst when immersed in water.

In every instance in which I have seen protoplasm escape into water it has displayed the tendency to ropy coagulation described by Mr. Wenham, and its granules when diffused in water are in active motion.

Mr. Wenham suggests that the form of embryo leaves may perhaps be given to them by pressure of surrounding and similar parts, but in the case of the Bryony this would not appear to be the case, for the embryo tendrils and leaves, though subjected to the same mechanical support or pressure, seem to have, from the very first, distinctive characters.

I must observe that, in the case of the Bryony, the transitions of protoplasm can only be observed with clearness at the margin of a mass; the thickness of central parts is too great for such easy examination as in the *Anacharis.*

The mere augmentation of bulk is best seen in the case of tendrils.

The phenomena of cell-division are most clearly defined in the hairs: the process appears to be hastened by adding a very small quantity of ammonia to the water.

I have in vain endeavoured to make out the manner in which spiral tubes are formed in the young parts: in most instances the spiral is seen to terminate abruptly, but in two instances I have observed that delicate striations were visible further on than the apparent termination of the vessel, and in every case there seems to me to be a straighter arrangement of the cells between which the spiral is about to pass, than elsewhere, so that probably a longitudinal interval between the cells exists, and this may become lined by a membrane upon which the spiral is developed; but all observations upon this point are rendered difficult and uncertain by the density of the masses between the vessel and the observer.

My observations were made with a power of 200 diameters, and an achromatic condenser.

In conclusion, I will remark that I have purposely omitted

what I noticed of cyclosis, &c., as I saw nothing new, and I cannot fix any precise period for the formation of chlorophyll-granules, or a membranous lining to a new cell, as I found very great variety in these particulars. My observations have been made during uncertain and scanty leisure, and are professedly imperfect.

VEGETABLE CELL-STRUCTURE *and its* FORMATION, *as seen in the* EARLY STAGES *of the* GROWTH *of the* WHEAT PLANT. By the Hon. and Rev. SIDNEY GODOLPHIN OSBORNE.

(Read June 24th, 1856.)

HAVING now for many months been engaged in an attempt, by means of the microscope, to trace the nature of vegetable cell-growth, I have great pleasure in laying the result of my investigation before the Microscopical Society.

Nearly the whole of my experiments have been made on the *wheat plant*. By means of various very simple contrivances, I have been able to grow this plant under conditions in which I could watch its actual course of growth with object-glasses as high as the half and quarter inch of Mr. Ross's manufacture.

In addition to observations made upon the plant in actual growth, I have made many hundred dissections of it, at the different stages of its early development; and I have now about one hundred carefully made preparations, embracing specimens of every condition of the progress of the contents of a seed of wheat, from the first indication of germination, to the full formation of the roots, and a growth of green leaf of from six to eight inches.

I have made no attempts to resolve any question in chemistry,—I have made no use of chemical tests. All I have to relate, is what my eyes have seen, and what I am prepared with pleasure to demonstrate from preparations I now possess. Unbiassed by theories I have read, I have sought after only such truths as could be practically illustrated by means of the microscope.

I have used throughout object-glasses, made for me by Mr. Ross, ranging from the two-inch to the twelfth power. The most useful I have found to be his improved half-inch, and a very excellent sixth. It is requisite however, or at all events convenient, to use the twelfth power occasionally, to determine minute features of structure which may be shown with the sixth, but not so clearly as to be beyond dispute.

In this paper I shall confine myself to that period in the growth of the plant, which gives roots of two or three inches in length, and an upward growth of the same height; this will be found to have afforded a very wide field of investigation.

In order to observe the growth of the plant, I pursued the following plan: I procured and constructed small glass tanks, which would rest on the stage of the microscope, their back and front being of thin glass; some were constructed sufficiently shallow to allow of the use of the quarter-inch object-glass.

In addition to these small tanks for observing the actual growth of the plant, I have a few glass jars, in which I suspend circular plates of perforated zinc over water which I treat with various matters; these plates receive the seed, in some instances without any soil, in others with a small quantity especially prepared according to the experiment I am about to make. From these jars I transplant the seeds, as they begin to germinate, into the small stage tanks; they also form my stock of subjects for dissection.*

I will now proceed to relate the history of early root-growth in a general way; I will then enter into the more interesting detail of the formation and character of the component parts of a root.

The first symptom of germination in a seed of wheat consists in the liberating from its surface a species of filamentous network, somewhat similar to the mycelium of many of the fungi which infest vegetables; nearly at the same time, the whole seed is seen to swell, and become, as to its external covering, somewhat transparent. At the germinating point of the seed, there now appears a very small wart-like projection of tough white matter; this puts forth one cone of the same substance, pointing upward,—the future plumule; and several others projected in a straight line, soon to curve downwards and be-

* At the commencement of my investigation into the growth of the wheat plant, I had a small nursery of it growing in my garden; I found, however, that though the results scarcely differed in the two cases, the plants from my jars being free from soil formed the better subjects for preparations than those grown in the ground. If a wheat plant is grown in very fine sifted soil, in one of the glass tanks, which should be so shallow as only to admit a depth equal to that of a root, a half-inch power will show a space between the soil and the apparent outline of the root; a quarter-inch will prove this to result from the intervention of a layer of transparent plasm external to the main structure. If in a similar tank the seed is caused to send roots down into clear water, by pouring in some coloured fluid it will be seen that the coloured particles adhere to this plasm, and cannot touch the actual parenchyma of the root.

come the roots (Pl. III, fig. 1). If this exuded white substance is examined at this stage, it will be found to consist of several layers of cell-texture. The outer one has cells with extremely thin walls; their length is far greater than their breadth, and very often they have no visible contents. The few next layers consist of thick-walled, angular cells, very full of granular matter. We then find smaller cells of the same form, the contents granular, but of a darker colour, with large nuclei occupying the greater proportion of each cell. We now come to the vascular bundle. This consists of tubes of scalariform,* or pitted fibre; I use the term tubes for want of a better, but I am satisfied that these long cells, with their barred and dotted fibre, are not hollow in the true sense of the word. They are firmly held in position by being placed within a mass of simple cellular tissue, which makes up with them the structure I have called "the vascular bundle." In the centre of this bundle, and passing throughout its entire course, are one or more tubes. I assume them to be channels for the sap; when dissected out they give, in a vertical view, two parallel lines of some hyaline substance, united by a highly transparent membrane, and enclosing granular matter.

A transverse section of one of these sap-tubes, made at the base of a root (Pl. III, fig. 2), shows two kidney-shaped outlines, enclosing in the space formed by their concavity a circular space, very similar in appearance to one of the nuclei found in cells. These bundles of fibre, with their investing layers of cells, are connected with the germinating point of the seed, by thick-walled, cellular texture (fig. 3), the spaces or cells being very full of a dark granular matter, in which globules of some oleaginous substance may be made out. The immediate connection of the epidermis of the plumule with that of the roots, is also a space of cellular texture, the cells of which, when divided vertically, are found to have their walls formed in minute cavities. The only idea I can give of a section of one of these cells is that of a series of pipes which have been bent into circles, laid upon one another, cemented together, and then a vertical section made through them, so as to expose their several inner faces. I find that cells of a very similar structure to these, will in the end assume the character of annular fibre, (*Vide* note at the end.)

The cones of protruded substance of which I have spoken soon burst their outer coat of cell-texture. At this early stage a root cone, if dissected out and placed under the sixth object-

* I use the word *scalariform* simply to mark the character of that species of vessel which has a ladder-like appearance.

glass, presents a very interesting object. At its apex there is what I must call a free capsule of cells (figs. 4 and 5), somewhat lozenge or diamond shaped at the extremity, but becoming longer and more narrow towards the base. These, as the rule, have well-formed nuclei within them; they have this peculiarity,—that they appear sometimes regularly disposed, so as to form, cell with cell, a perfect cone; at other times they are separated into groups; again, it will often happen that many of the cells will appear to be isolated. They take this varying position from their being formed in, and held together by, a highly elastic and very transparent membrane.

This free capsule envelopes the inner apex of the growing root; but there is, as a rule, a clear cell-less space between its base and the part of that apex which it there covers. Very frequently the cells at the base of the capsule will be seen to project from the side of the root at an acute angle (fig. 5.) Beneath this cellulated cone or capsule, the growth of the root, throughout its whole progress, proceeds as I have already described it; the only difference from its very early stage being, that the scalariform fibre in the vascular bundle assumes a more defined form, and the whole structure larger proportions. The capsule, however, is never missing, nor have I ever found it to vary in its structure and general details.

It is these capsules, I believe, which botanists have named spongioles. I have a preparation in which I have succeeded in getting a view of the apex of a capsule *in situ*; as it were, looking down upon it (fig. 6). A sap-tube is seen bedded in a series of cells, which surround it in concentric circles, giving, under the sixth power, the appearance of a small dahlia.

As the rule, every root, at a certain period of growth, unless it is forced by heat or some very fertilizing matter, very soon puts forth rootlets and suckers. The suckers consist of long, narrow, cell-like structures (fig. 7), the result of cell growing on cell, and the absorption of their walls of separation. They contain fine granular matter, and at their extremities there is a cavity of peculiar form always full of it. They take their origin from cells in the parenchyma, and may be traced through every stage of their growth.

Besides these suckers, small lateral roots spring from the parent root (fig. 1 DD). Their structure is identical with that of the root itself; when detached and put up as preparations, they afford a beautiful illustration of the various forms of cells.

The nature of their growth is this:—The epidermis of the main root slightly bulges outwards; on this a mass of granular

matter is seen to accumulate; in it are a great number of nuclei, enclosed in minute egg-shaped vesicles (fig. 8 *h*), each nucleus being situated at the lesser end of the oval space in which it is contained. External to this granular matter, certain hyaline, thread-like processes (fig. 8 *i*) are seen interlacing with each other, forming thus an irregular network. A vertical section of that portion of a root which is producing one of these lateral roots shows a small vascular bundle, anastomosing from the centre bundle of vascular fibre in the root itself. This is surrounded with concentric circles of small cells, disposed with the utmost regularity. The new vascular bundle, with its envelope of cellular textures, now protrudes a cone-shaped apex into the external accumulation of granular matter; that matter, with its network and numerous vesicular bodies, becomes to this protruded cone what the free capsule or spongiole is to the main root. It speedily assumes the true capsular form. The small vesicles expand most rapidly; their outer walls become in contact the one with the other, and by this compression they are forced into that peculiar form which is ever characteristic of the inner cell-structure of a capsule. The outer network appears now to resolve itself into a certain predetermined form of structure; it is seen in union with a plasm, highly elastic, and equally transparent; this fills up spaces to which what appeared as mere threads are now the walls or septa; and thus that peculiar external coat of cells I have already described as seen on the point of a root, comes into a visible existence (fig. 9). Simultaneously with this assumption of their normal outline, are seen the nuclei so generally found in them. These cells, bedded in the plasm in which and of which they are formed, now partially subdivide, and the whole rootlet (fig. 11) thus obtains all the outward form and internal structure of the parent root, to which it is connected—without by a common parenchyma, within by the vascular bundle with its cells, which has anastomosed from the parent root. The base cells of the capsules of the roots and rootlets are gradually brought into connection with the parenchyma. Perhaps it would be more proper to say that the parenchyma is formed by the gradual addition of the lower cells of the capsules, to former cell-texture of the same kind, which has become the epidermic covering of the root. I believe it will ever be found that there is a clear space of membrane or plasm between the base of the capsule and those of its cells which were last drawn in to be incorporated as part of the parenchyma.

Exterior to the cellular parenchyma, I long suspected that there was a coating of some hyaline plasm investing the

whole structure of the root; this, by the process of *colouring*, which I shall presently describe, I now can easily prove to be the case. It is highly transparent and is seen as a clear glass-like envelope to the substance it invests; I will call it "epidermic plasm;" I believe it to be identical with the connecting membrane or plasm by which the cells of the capsules are held in position. If the point of a growing root is removed from the plant, and the capsule separated on to a slide of glass, a drop of fluid added, and then some compression made with a thin glass cover, by a patient manipulation of the illuminating portions of the microscope, this plasm is very easily made out.

Having dealt with the general features of the growth of the root, I will now turn to that of the plumule or leaf. A section made with care through the white substance, from which the plumule and roots both protrude, gives a beautiful view of the early formation of the former. Several layers of an oval-headed cell-structure are seen, the one longer than the other, *i. e.*, more advanced in growth, the shortest or youngest being very small. When detached from each other their outline is that of a blunt spearhead (Pl. V, fig. 19); at this stage their substance consists of a cellular texture, of which the cells are very small as to their actual area, with rather thick walls of plasm. Towards their base, in the centre of each, is the well-defined indication of an upward line of spiral fibre. These are the embryo leaves. They have the same epidermic plasm as the roots, and into it are seen to project small points, the future hairs on the leaf of the plant. They have capsules, so far as I can make out, identical in structure with those of the root, although adhering more closely to the substance covered, and the component cells do not separate in the way they do in that part of the plant.

As these young leaves prepare to enter into the outer world they fold themselves longitudinally into a very small compass (Pl. V, fig. 29), and carry on with them, until they have obtained an inch or so of growth, a straw-coloured cellular envelope of stout texture (Pl. V, fig. 30); this appears intended to protect them as they force their way through the soil and on their first exposure to the weather in the outer world. It has occasioned me some surprise to find the chlorophyll or green colouring matter existing in leaves at so early a stage of growth, that I can hardly attribute its existence to any action of light.

The spiral and other fibre given off into the leaves originates from a mass of the pitted or dotted cell-tissue which is seen in the centre of the white substance, from which, as I have stated, plumule and roots both grow. If a section is

carefully made through this substance, in a direction which will include the lower part of the plumule and the commencement of the roots, we get a view of the basis of the whole vascular system. A large number of pitted cells are seen, some passing downwards to branch out into bundles, one to every root; these, as soon as they reach the base of a root, assume a modified scalariform appearance; others branching upwards to the leaves assume either the spiral character or that of a double band, of which one part is scalariform, the other annular, or the broad spiral breaking up into rings. The origin of all these vessels would seem to be similar—cells of a long, ovate form, so indented or pitted, that with proper illumination their surface presents a reticulated appearance (Pl. V, fig. 37); where they join at their extremities they widen, their intermediate walls absorb, and thus one long vessel is produced by the conjunction of many distinct cells.

Turning now from general structure, I will enter more into detail as to the formation of those cells of which every vegetable structure is composed.

If a seed of wheat is permitted to so far germinate, that the plumule and roots are thoroughly developed, it will, by pressure upon a glass slide, give out a certain amount of milky-looking matter. If this matter is mixed with a few drops of distilled water and spread out over the surface of the glass, as it dries up I have ever found it to assume the same appearance—that of nearly parallel lines connected at irregular distances by curves, presenting an appearance of the form and character of cellular tissue. I only mention this fact, as one that, with others, has led me to believe that the formative matter of a seed in this stage of germination has a direct tendency to resolve itself into a form characteristic of the tissue which is so wonderfully to be educed from it. As far as I can trace the changes within a seed germinating, it appears that, by the breaking up of its outer tissue, the moisture requisite to decompose its contents is admitted. The granules of the starch now burst and become mere vesicles, having exchanged their normal outline for one more oval; their concentric markings and hilum, for a plane surface extensively lacerated by that bursting of their tissue which has liberated their contents. The formative fluid at this stage is found full of these torn vesicles of the starch granules, with a large amount of glutinous and also of active molecular matter.

In the next more advanced stage of this matter I obtained some of my best specimens by the following simple means:—I put a certain quantity of the milky matter expressed from

seeds, whose roots and plumules had grown about half an inch, into short glass-pointed tubes, with very small terminal apertures, adding to it a very little water; I then suspended these tubes in jars full of water, covered with tinfoil; these I kept for ten days in a dark, warm cupboard. I now found that a large globule of a light brown matter had exuded, and was attached to the points of the tubes; this I carefully removed, and made into a preparation capable of being examined with my "twelfth" object-glass. I now obtained some further insight as to the forms into which the fluid contents of seeds germinating are resolved; from this and many other experiments, I have arrived at the conclusion, that the formative matter, at that stage immediately preceding actual cellulation, is composed as I shall now describe it. There is a very transparent glutinous matter, only to be traced at its edges, when floated out into distilled water or any clear fluid; in this there is a large quantity of granules of a peculiar form (Pl. V, fig. 32); with the sixth power they have an appearance similar to that of vibriones, but still being clearly of quite a different character. By the use of the twelfth power, with good illumination and a careful manipulation of the instrument, their peculiar form can be well made out. I call them "double ovate granules;" they seem to consist of two very minute oval vesicles, which have become united, or it may be of vesicles of that form, originally single, but which by a process analogous to that followed by some *Desmidieæ* have become double; they have a molecular movement, but this is not universally the case, and I am not satisfied that it does not arise from their contact with other active molecular bodies.

In addition to these double ovate granules, which I consider to be vesicular, there is a large quantity of some thick granular matter evidently made up of most minute atoms, the characters of which I cannot trace out; there are also a great many true molecules in constant motion; they are very similar to, but smaller than those I have often taken on glasses exposed to the atmosphere.

By some curious law the double ovate granules voluntarily dispose themselves in a manner which, by leaving clear spaces between groups of them, gives the appearance of a somewhat vaguely defined cell-texture; the molecular atoms, by as evident a law, will be found to hold with regard to each other, as the rule, a relative distance so regular as to force upon me the conviction that it is in their very nature to resolve themselves into certain set forms (Pl. V, fig. 32).

I had observed that, whenever a lateral root commenced its growth on a plant in one of my stage tanks, there was

an external secretion of a brown granular matter; I have already described its general features; I have frequently removed some of this, and submitted it to the sixth and twelfth powers: this gave me a view of the formative matter in a further advanced stage. There were the double ovate granules and the molecules, but I now get true cell-formation and nuclei in their earliest existence (fig. 33).

Imbodied in the mass were globular bodies, whose external surface afforded a distinct circular outline; they were full of granular matter very closely packed: in their centre was a spot or ring, and even within this I have often made out another spot; these were nuclei with nucleoli, which latter had also their own nucleoli. Some of these were deeply imbedded in the formative matter; others, more upon its surface, were seen contained in small vesicles or cells, inclining to the oval form. At the edge of the mass the use of a $\frac{1}{4}$-inch power had permitted me to see the thread-like transparent processes to which I have already alluded; now the matter itself was removed on a slide, and submitted to the higher powers, I found these threads to be of a beaded structure: after-experiment leads me to believe that this network is in reality the outline of walls of separation in the plasm, which invests the whole mass of formative material.

If the capsule of a root, when very young, is removed to a slide, and there in some clear fluid submitted to pressure—flattened out between two pieces of thin glass—the outline of many of the long cells will appear in a series of curves (Pl. IV, fig. 12, 12*); it will be also seen, that where two cells are a little separated, the curves of their several outlines are in exact opposition to each other, the evident result of their recession from the spaces which they had enclosed when in conjunction. I followed out this observation, until I arrived at the conviction that the cells of these capsules, or spongioles, arise from a floating out of a highly elastic plasm, its self-separation into many individual spaces, which again divide into more; the curves or indentations in the respective walls of separation expanding as they separate, again to unite and enclose spaces which are to be fresh cells.

It was the desire to trace out this feature of cell-growth which led me to seek the means of giving colour to the formative matter. To my delight I now found that whilst the mass would take up or involve the pigment, the actual cell-walls and epidermic plasm would not. I now obtained preparations of these long cells of the capsules, on one side empty, the whole of the other side full of the pigment (Pl. IV, fig. 19), this coloured portion affording the exact

form of the cells I had seen to separate by an apparent splitting of the beaded division; the use of a high power now enabled me to see at the inner edge of the coloured portion of the cell, the growth of the future line of division.

I have just said that the cell-walls will not take up the coloured matters I use; the viscous hyaline matter in which the formative granules and molecules float will do so to a certain degree. I am inclined to think this is of a different nature from what I have called "epidermic plasm." I am of opinion that all the granular and molecular matter I class as "formative matter" exists imbodied in a very thick transparent fluid, that it is this which effects the various combinations of cell-contents; I have succeeded in colouring it, but I have my doubts whether the tint I have given does not in reality proceed from exceedingly small coloured granules, which are so closely incorporated with it as to impart their own tinge; when a well-filled and coloured cell is bruised out upon a slide, the intimate connection between the coarser material and this viscous matter is clearly shown.

The epidermic plasm I have never yet found to take any colour from any of the means I have used to paint the internal matter of the cells; although so elastic as to often resist the strongest attempts I can make to separate it from the structures it invests, when broken up, its edges have the appearance of broken glass. I believe this plasm to be equally the integument of every individual cell, as it is of every combination of cells. In portions that I have succeeded in detaching, I have observed the vesicles containing nuclei, the latter highly coloured; also the early stage of the beaded network of which I have spoken.

It is impossible to value too highly the help given to the study of cell-growth, from the use of colouring matters applied to the growing plant. Amongst others it reveals this curious fact—that the smaller the organism into which the pigment can enter the more highly painted will it appear (Pl. IV, figs. 23, 28). This arises, I believe, from the circumstance of the formative matter being more closely packed in the smaller spaces into which it is received; the plasm enveloping colour and formative matter alike, when it contracts upon them to form the nuclei, so closely aggregates the granules that their whole mass acquires a deep colour. In the small cells, which are so beautifully distributed in the vascular bundle, the walls preserve their full transparency, the contents take an evident amount of colour; a clear outline shows the vesicles containing the nuclei; these nuclei are seen very highly coloured. You have thus under the

object-glass several generations of growth, each painting itself with a distinctive shade drawn from a common source of identical colour (Pl. IV, figs. 24, 25). Under every feature of cell-growth, the nuclei and the aggregations of formative matter which tend to nucleolar growth, will always be found to present a much deeper colour than the formative matter in the same cell with them.

I do not consider all masses of formative matter, tending to the globular form, within cells, as nuclei. There will often be a mass of granular contents, somewhat globular, seen at one edge of the middle of a cell (Pl. IV, fig. 14), on which it is impossible to make out any membranous investment; it will gradually increase by taking to itself more of the mass of similar matter contained in the cell, or by its own expansion, until it occupies a very large portion of the cell-cavity; a line of separation then appears above and below it, caused by the formation of two new cell-walls or divisions in the cell, in which this process is taking place; this mass of granular matter now assumes a quadrangular outline, entirely filling a space separated for it in the cell by the new walls. The portions cut off by the interposition of this new formation increase by expansion, as it does itself, and thus one cell becomes three (Pl. IV, fig. 27).

With regard to the true nuclei, those with a well-defined outline and the nucleolus within them; before these take any visible part in the work of cell-propagation, with scarce an exception, I see the gradual formation of the egg-shaped vesicle of which I have spoken; this vesicle is seen to increase its proportions, the nucleus for some time remaining inactive at the broader end; a new cell is thus formed, apparently within an old one; when it has attained a matured dimension the nucleus seems to break up or disperse within it; after an interval a new nucleolar formation is seen, prepared, I assume, to follow the same course.

Besides these processes of cell-growth—that from an irregular aggregation of cell-contents (Pl. IV, figs. 16, 17, 18), and that by the vesicular investment of a nucleus—there are combinations of cell-contents into masses with oval and other outlines, which I cannot trace as taking any part in cell-propagation; they will often be seen in the matured parenchyma, of a long, oval form. I am inclined to regard them simply as a secretion from the cell-walls, often absorbed, to be again secreted in the same form.

In portions of a plant where the growth is very vigorous I frequently find two, sometimes three, nuclei in one cell, very often two in one vesicle (Pl. IV, fig. 28). The use of colouring

matter has also given to me evidence of another process of cell-growth. I have stated that where the formative matter becomes closely aggregated, either in nuclei or in the masses with a less defined form, it takes from the pigment a darker hue. This has shown me that the cells in some root structure are produced on what appears to be a very simple plan. A large amount of the formative matter will have taken up the colour used; on its surface you trace a network of plasm floated out; the lines of this will be seen to dip down into the mass, and to form septa of some breadth, thus dividing the granular coloured matter into quadrangular cells: by close observation with a high power it will be seen that these septa are not composed simply of the deposit of one layer of plasm, but of several (Pl. IV, fig. 27). The matter thus divided and coloured will occasionally (it may be from the action of the preservative fluid I use) shrink up into folds within each division; it is then made evident that besides the cell-walls the granular contents of a cell are enveloped or blended in their own particular tissue.

After giving much attention to the subject, using the highest powers of the instrument, and many different kinds of illumination, I have arrived at the conviction that nuclei, when seen in cells, either alone or with vesicular investment, are exterior to—have a separate existence from the other granular contents of the cell. Now, I am quite satisfied that the plasm which forms the cell-walls consists of several layers; if, as I conjecture, these layers are continuous, *i. e.*, extending without interruption from one cell to the next, I can easily conceive the facility with which a cell formed external to the surface of the enclosed granular matter could extend itself between any of these layers, and thus force its way into a distinct existence, increasing the bulk of the structure of which it formed a part. I am confirmed in this view from observing the extremely elastic nature of the cell-wall plasm. The apex, even of the youngest root, requires considerable pressure before it can be so broken up as to admit of being made into a preparation capable of being studied with a high object-glass.

A transverse section of a root will sometimes show the dark masses of young cells, when in vigorous growth, forcing their way through the angular spaces formed at the points of contact of the divided cells; frequently they will be seen pushing their way on one side of the interior of those cells. I hold, then, these nuclei to be a very close aggregation of formative matter, by some law combined in the globular form, and sustained in that form by means of the viscous material

in which all such matter is suspended; that by another law, a highly elastic vesicle is secreted external to a nucleus; in its progressive expansion it forces its way, utterly independent of the other contents of the cell, into a layer of the plasm of which the cell-wall is constructed, until it has itself obtained the dimensions and general character of the cells of that particular portion of the vegetable structure to which it belongs; that then the nucleus within it expands by the general separation of those particles of matter of which it is composed, until it has filled the space formed by the new cell which had been its *matrix*. The cell, now matured and occupied by the contents thus derived from the nucleus, absorbs some of them, and then, either by entire fresh secretion, or partly by that agency in combination with some portion of its original contents, a fresh nucleus is produced, to run the same course.

That the epidermic plasm of these vegetable structures can secrete formative matter on its external surface, I have no doubt whatever, for I have again and again watched the process. I see no reason to doubt but that the plasm of the cell-walls has the same power with regard to its internal surfaces. On this power of external and internal secretion of tissues, which involve every portion of the organisms to which they belong, I think a sound theory is to be founded as to the whole process of vegetable cell-growth.

Those who pursue this investigation will for ever find instances in which matured cells would seem to be isolated. I am satisfied that, in reality, this is never the case. They may be accidentally torn apart, or floating out from each other on or in the plasm in which they are produced, from its exceeding transparency they may appear to be separated, but when *in situ* with regard to the structure to which they belong, they are ever in connection either with the walls of neighbouring cells or with those wonderful layers of elastic membrane whose evolutions and convolutions form a protecting, secreting, absorbing, and assimilating surface, extending to every portion of the system of vegetable structure.

I have now grown wheat plants rooted in spring water, distilled water, in a solution of alum, in spring water coloured with carmine, vermilion, and indigo. I have treated the water in which they were growing with various fertilising matters. I have grown them in thin layers of soil suspended over water, mixing with that soil various ingredients, and pigments, and bronze powder. I have now plants, with a foliage of fourteen inches, growing in a strong solution of prussic acid

and cyanide of potassium. It would be too great a trespass upon your patience to give all the various results of these experiments. The general conclusion at which I have arrived is, that, though what I call the epidermic plasm does absorb moisture from the soil, in fact requires moisture to preserve its elasticity, combining in the formative matter it secretes some of the matters presented to it, in whatever medium it may grow, still the great sources of plant health and strength are obtained by means of the capsules or spongioles, the *termini* of every root and rootlet, and also by the absorbent cells ever found at the extremities of the numberless suckers; for it is at these points that I find the cell-structure ever greedily taking in whatever of foreign matter I have succeeded in introducing into the *media* in which I have grown the plants. The action of anything placed in the medium in which plants grow, which is injurious to them, is at once shown by its action upon their roots and lateral processes, the capsules losing many of the characteristics of healthy action. It is a curious feature in these experiments that, although deep roots give a great deal of green leaf to the plant, yet when pernicious substances or fluids stint the roots by injury to the spongioles, *for a time* there is nevertheless an active leaf-growth. I am also strongly impressed with the belief, that the hairs with which the surface of the leaves of cereals are so regularly studded, receive from the atmosphere and introduce into the leaf-structure those atmospheric elements so necessary to its growth. I have never yet traced any circulation in any part of the plants on which I have experimented, but I have seen active molecules at the base of some of these hairs, and in one instance crystals of the character of oxalate of lime.

When the spongioles are poisoned or mechanically injured, the internal cells of the root are imperfectly developed, they appear as mere quadrangular masses of granular matter floated or imbedded in hyaline plasm, with few aggregations of the matter, and very few nuclei, these being irregularly formed. Distilled water is an easy means of proving this fact, a rather strong solution of alum, also soil mixed with the bronze powder, which latter binds the soil into a hard mass. There can be no doubt but that the plant requires not only certain chemical constituents to secure its health, but that these must be offered to it, when growing in a medium, allowing the utmost freedom to the capsules of the roots, rootlets, and to the suckers. I am satisfied a highly pulverized poor soil would grow better plants than a close, hard, tenacious soil, however fertilised.

I will now briefly remark upon those beautiful structures known as scalariform, spiral, annular, and dotted fibre. In the leaf of the wheat I find the true spiral,—the annular, the scalariform; in the roots I find only the latter, with an accompaniment of dotted tissue. At the very earliest stage at which, by dissection, a view can be obtained of leaf and root formation, the fibres proper to each are discovered, the spiral completely formed, the scalariform in active formation; the former turning upwards to the leaves, the latter separating into bundles and going downwards to the roots.

The formation of the scalariform fibre can be with ease traced. A large number of pitted oval cells, of considerable size, flow down as so many streams from the centre of the base of growth. Some are seen with their end walls already absorbed, and their centre diameter contracting. A section of them made at this stage, shows that the pits in their walls extend in lines around their whole internal structure; these now unite, so as to form furrows or folds. By looking into a tangental section of one of these cells, you may see in the interior an appearance as if the whole had been built up after the manner of a wall, for the divisions between each pit or depression are not quite obliterated. A small piece of such a cell, detached and flattened, has all the character of a fine hyaline network. Being anxious to discover in what form one of these scalariform fibres became developed at its extreme point, I have made several preparations of the vascular bundle, with the outer cell texture removed. By this means I have found that each of these processes push on in their growth exactly on the principle by which it commenced; they become periodically more contracted, and end in long, narrow, complete cells, with toothed edges, more similar to those of the fibres seen in the crystalline lens of the eye of a fish, than to anything else with which I can compare them.

I have one preparation, in which I have a beautiful specimen of this scalariform fibre, in close contact with true ribbon-like fibre disentangling itself, and perfect rings of the annular; this is from the plumule. None of these vascular tubes can I succeed in colouring. I have no doubt but they are formations developed from elastic plasm, and by some law, assuming, according to their situation in the plant, their own peculiar character. It is easy to conceive that the folds of the scalariform could become annular; that the annular might be modified to become spiral; but I can form no conception as to the process, by which from an apparently homogeneous substance, the separation of two differing sys-

tems of vascular tubes is so produced, as to send the one more simple system to the roots, another, with all the varieties of structure, to the leaves.

With regard to the leaf, I believe the chief office of the spiral fibre is to support and give general strength. It will be seen here to anastomose, small branches passing from one main vessel of this fibre through the cellular substance, to unite with another similar vessel. I have never detected this, as existing in the case of the scalariform vessels of the roots. These I believe to be also formed for the direct purpose of strengthening the structure with which they are incorporated. They become a species of elastic skeleton to an organized body, where every purpose requires that it should at the same time be supple and yet strong. The only anastomosis to be seen in these vascular fibres of the roots, is where one of them gives off a bundle to a lateral root. Although I have succeeded, by the use of the air-pump, in forcing a little coloured fluid between these fibres and the cell-texture which invests them, I can introduce nothing into their own substance.

When I look at what a wheat root has to do; how it has to force its way and introduce its lateral branches through all manner of crevices, and amongst all kinds of material in the soil, I am struck with wonder at the beauty of the contrivances by which the spongules or capsules, constructed of highly elastic material, can float their onward way; consolidating as they grow, and having within them the growing organism of a scaffolding sufficiently strong to bear up, in its deposited order, all the necessary structure; and yet sufficiently pliable, to follow that structure in any course it may be compelled to take, however tortuous.

By growing the wheat plant over spring water, and then submitting the leaves to a continued boiling in nitric acid, very beautiful preparations of the pitted tubes and the rings of the annular fibre are obtained. If there are casts in silica of the original vessels the silice must be taken up from the water.

I will only now add, that I will with pleasure give any further explanation upon any point on which I have now touched, and any information as to the manner in which I have made my experiments. I believe a close study of the growth of plants, by means of the perfect instruments we now possess, if pursued, not by mere amateurs like myself, but by men of real scientific knowledge, would lead to most useful results. Science has done a good deal in teaching us how best to enrich our soils. Histology may yet throw valuable light on

the processes, by which the plant takes up for itself the food we offer it. A close study of the mechanism employed by nature, will show to us in what form, and under what conditions, fertilizing matters can be best applied, so as to secure their most perfect assimilation.

Allow me also to say that, in my opinion, no student of animal physiology can pursue this course of research without being struck at every step with the very strong analogy existing between the development of vegetable and animal structure. I will not trust myself to enter into this subject further than to declare, that every day's work on vegetable structure has given to me a new interest in every page I read which relates to the structure of animal. I cannot but think we are approaching a time when the microscope, in the hands of men of science, will prove in these two fields of God's wonder working, the existence of a strictly analogous principle, developing and sustaining animal and vegetable life, with only that much of difference in the processes which the obvious purposes of the two existences would lead one to expect.

Since I have put to paper what I have now read to you, I have made a few preparations which I think it may be interesting to describe before I show them. I have stated my belief, that the roots of the wheat take in nourishment for the plant from the medium in which they grow, by means of their capsules, and those on their rootlets. I should have perhaps better expressed what I mean if I had said at these points of their structure. Wishing to make some experiments on the action of poisons, I grew a small crop in a strong solution of prussic acid with cyanuret of potash added to it, I found this gave a very vigorous growth to roots and leaves. Just as the root had acquired about four inches of length I applied my colouring matter to the fluid in which they grew; I wished to see whether this would be taken up anywhere but at the above points. I will show you that it was not, that the parenchyma or outer cell-texture is colourless, that the capsule-cells are strongly painted; that as they have pushed on nothing has been left in the matured cells *coloured* but very small nuclei, excepting only along the whole course of the vascular bundle; here what I call the pith-tubes will be seen to have imbibed the pigment, and it can be traced along their whole course, *i.e.*, along the whole course of the growth made since the solution was coloured.

There is another curious and, to me, most interesting result from this experiment. I have said, I believed the nuclei to be aggregations of the formative matter in plasm, I have also

said that this plasm, though clearly elastic, at times gives the appearance, when broken up, of broken glass. Under the twelfth power, nuclei which I have managed to break within their cells, present the appearance of minute glass beads of coloured glass which have been crushed. It is true the nuclei grown in this solution differ from any I have before seen, in their extreme minuteness, the utter invisibility of the granules within them; still, there they are with their nucleoli in *situ*. The pigment has made them tell a tale which I scarcely think any other means would have extracted from them.

Note.

Since the above paper was read, at a meeting of the Microscopical Society, I have made some further investigation into the origin and growth of those vessels of which I have spoken, as pitted, scalariform, annular, and spiral. The earliest stage at which I can trace this vascular form, is in the shape of cell-wall, with very minute pits or depressions arranged in an order with regard to each other, either linear or spiral, the cells themselves being generally ovate. As soon as their *termini* become absorbed, and they thus become portions of a continuous tube, the pits are seen to enlarge and assume a long oval character; these pits are based with a very thin membrane, and in this a small dark spot is perceived, the commencement, as I believe, of actual perforation. At the next stage the entire basement membrane has become absorbed, and the perforation of the cell-wall is now complete in a series of oval apertures. In some instances these are so directly in line that, as they elongate and break into each other, the tube-wall is cut into straight lines, consisting of that part of its texture which existed between the original rows of pits; and thus those bars are produced which characterise the ladder-like tube seen in the root of the wheat, and in other portions of many plants.

For a considerable time I was perplexed by observing certain dots or circular spaces, whose close conjunction at the ends of the bars, formed as it were, the sides of the ladder of which the bars were the steps; I at length solved the mystery; I find these vessels, at that stage of their growth when they assume the scalariform appearance, are pentagonal, the dots being nothing more than the action of the light at the angles, the divided cell-wall being also at the said angles rather thicker than at any other portion. I have made preparations clearly proving this to be the case in transverse sections of

these tubes. By tearing out the bars they come away in a ribbon of fibre, spiral, but yet such a spiral as would result from the twisting wire tightly round the surface of a pentagonal block of metal, and then unwinding it so as to partially release it from the form into which it had been thus forced.

The annular vessels—those in which distinct rings are seen—are formed upon a similar principle, but in this case the cell-wall is first pitted and afterwards perforated in true lines, and thus it becomes eventually cut up into ring upon ring; these are with ease separated, and are seen to be also pentagonal. Thus, from a mere dotted or pitted texture on the walls of the true cells, is produced; first the scalariform character, and this, according as the direction of the pits may be, assumes, when they run into each other, the spiral or angular form.

If one of these tubes is split up, or cut vertically, at that stage when the perforations are complete, the edges of the divided structure present a series of squared projections, with clear spaces between them.

With regard to the spiral fibre found at the very earliest stage of vegetable growth in the plumule, I cannot trace its formation; it seems to come to maturity simultaneously with the earliest growth of the vegetable substance in which it is seen, not being subjected to the same pressure as that I have described above, which grows more gradually, and is bound up in a mass of other cell-structure which has grown in advance of it; it does not assume the pentagonal form. I can form no theory as to its production; I cannot find it in the seed, but I find it complete at the earliest stage in which I can dissect any of the substance protruded.

I cannot discover any exterior wall or membrane enveloping these formations; I believe them to hold their position by being built in by the surrounding cell-texture of the plant; in the roots of plants they are themselves an external protection to the sap-tubes I ever find in the bundle formed by them. I have made several preparations of vascular tissue of the most eccentric form, such as I cannot resolve into either annular or spiral, I am inclined to believe that these are often the result of the pressure of the covering glass. I have never yet been able to trace any visible contents in any of these vessels.

On LAAP, *or* LERP, *the* CUP-LIKE COVERINGS *of* PSYLLIDÆ *found on the* LEAVES *of certain* EUCALYPTI. By THOMAS DOBSON, Esq., B.A., of the High School, Hobart Town. Communicated by GEORGE BUSK, Esq.

(Read April 30th, 1856.)

THE white saccharine substance called "lerp," by the Aborigines, in the north-western parts of Australia Felix, and which has attracted the attention of chemists, under the impression that it is a new species of manna, originates with an insect of the tribe of *Psyllidæ*, and order *Hemiptera*.

According to Latreille ('Dict. Classique d' Hist. Nat.' art. *Psylla*) only six species of this genus are known, and these are all proper to Europe.

The three species described in this paper are, in all probability, new to entomologists.

The larvæ of several insects avail themselves of their peculiar secretions to form a rude tent-like protection from their enemies and the weather. Those of the *Crioceres* are concealed under an irregular mass, having the appearance of macerated leaves. The *Cassidæ*, *Coccidæ*, and *Psyllidæ* are hidden under a cloak of white cottony filaments flowing from the articulations of the body. The *Psylla Eucalypti* enjoys a more profuse supply of glutinous pabulum than its European congeners, and is thus enabled to construct a more artificial and effective dwelling. It is, perhaps, owing to the remarkable dryness and mildness of the winter just past that these insects have been obtainable in their various phases of transformation at all times during the last four months. The white conical tents of the larvæ and pupæ may be readily detected on the leaves of the lower branches of the stunted gum-bushes in the Government domain here; the groups of minute ova are not so obvious, and the perfect insect is seldom seen abroad. It is more often met with in a quiescent state, after it has cast off its pupa skin, and while its wings are yet moist and shrivelled up. Its existence in the perfect state is either very ephemeral, or it escapes observation by its incessant restlessness, and the peculiar faculty of leaping, to which it owes its generic name.

To the unaided eye the eggs appear like small yellow granules scattered in groups on either side of the leaf, and unprotected by covering. (Pl. II, fig. 1.)

Under the microscope they are seen to consist of a translucent pyriform membrane inserted into the leaf by a pedicle, and containing an amber-coloured fluid of somewhat darker hue near the neck or fixed extremity. Just before

the exclusion of the larva, the egg bursts longitudinally from its free extremity. The body of the larva is nearly transparent, except the eyes and dorsal vessel, and resembles in form that of the subsequent pupa. An early stage of the pupa's growth is shown in fig. 2. A thick uniform cylindrical thread of a transparent viscous fluid issues from the anal aperture, and terminates in a considerable globule.

Finer filaments proceed from between the rings of the abdomen, near the extremity of which are two principal excretory glands. At almost every articulation of the body and limbs the microscope reveals minute globules of this white fluid.

Four lateral tubular cases contain the rudimentary elytra and wings.

Fig. 2 also exhibits the first framework of the conical roof. Portions of the strong central thread have been turned up the back by the bifurcated tail, one extremity of each portion rests on the leaf, the others meet together and form a rough apex to the framework over the back of the insect. By turning round its body the finer filaments are passed from rafter to rafter in the inside, until they form an open basket-like covering, and combine into one thin glutinous cup-like sheet. The subsequently secreted fluid oozes out in drops at the base, and hardens and elevates the original roof on the wall formed by these accretions. This occasions the appearance of superposition, and the lateral displacement of the apex observed in most of the specimens of old lerp. (Fig. 5.)

When the pupa is about to undergo its final transformation, it escapes from its skin through a fissure down the back, eats its way out of the cone through a round hole, and leaves the skin within.

But when the base is not too firmly attached to the leaf, the pupa creeps out from beneath, and throws off its skin on the leaf. The perfect insect is represented in fig. 4. The antennæ are filiform, and have ten articulations. The two first are much shorter and thicker than the others, and the last is terminated by two hairs. Two elongated parallel tubes compose the "sucker," as it is improperly called, with which the insect pierces the leaf, and procures its juices. The eyes are prominent, globular, and compound. Immediately behind each eye is an *ocellus*. In many individuals a third ocellus appears in the central furrow which divides the head longitudinally, and therein they agree with the general character of the genus according to Latreille, Milne Edwards, &c.; but in others, as in fig. 4, this central ocellus is replaced by two

ocelli separated by the furrow. This duality of organ accords well with analogy, and disposes me to believe that what has been hitherto considered a third central ocellus is really a combination of two minute ocelli, whose proximity and oblique position render them incapable of separation by our microscopes.

The wings are much longer than the body, and nearly colourless. The elytra are longer than the wings, almost of the same consistence, and deflexed. The abdomen is of a rich emerald green, and is terminated by two pointed projecting pieces, which play an important part in depositing the eggs and constructing the roof. The feet are furnished with two hooks, and a small membranous bladder. These vesicular appendages, as well as the antennæ, are continually in motion. The insect seems to prefer locomotion by running and leaping to that by flight. The male is somewhat smaller than the female, but presents no prominent difference in other respects. The description given by Dr. Anderson in the 'Edinburgh New Philosophical Journal' for July, 1849, of the form and structure of the small white cones, is sufficiently minute and accurate. The tuft of hairs seen on most specimens consists of portions of the thick central thread which have failed to retain their hold on the surface of the leaf. If Dr. Anderson is correct in stating that the saccharine taste of lerp is confined entirely to these external hairs, there must exist a remarkable difference between the usual excrementitious matter of which these hairs are composed, and that secreted and expelled from between the abdominal rings, &c. In insects which subsist on vegetable juices, the salivary vessels are developed in an extraordinary degree; and whether the fine silky filaments exude from the salivary glands, as in the caterpillar, or are elaborated by a special secretory apparatus, it is quite conceivable that their nature may be very different from that of the excrementitious matter which has been subjected to the action of the various organs composing the intestinal canal. The ants are extremely fond of lerp; and the beautifully marked spider whose dwelling is a gum-leaf folded and laced together by white threads, has generally one or two tenanted cones and a large ball of fluid lerp within its abode.

I have recently met with another species of *Psylla* located on the red-curled leaves at the extremities of fresh young shoots, and protected by a different kind of lerp. The edges of the leaf are turned over so as nearly to meet; and within each of the two grooves thus formed is a series of white opaque shells of an elongated oval shape. (Fig. 3.)

They are of a waxy consistence, and tasteless. The lower part is a thin film adhering to the surface of the leaf; the upper is much thicker, and covers the insect enclosed as in a bivalve shell. Overlapping each other like the scales of a fish, the upper valves form two rows down the sides of the leaf. The perfect insect (fig. 7, nat. size) is about one half larger than the cone-forming *Psylla*, the head and prothorax are of a bright yellow, the remaining segments of the thorax are dark brown, the abdomen a yellow green, and the elytra yellow, with two elongated dark brown spots at each tip.

When my attention was first directed to this subject, more than four months ago, I found, besides the common white lerp and its occupant, a larger and differently coloured lerp, with its peculiar *Psylla*, surpassing in beauty and structural development the species already described. The eggs of this third species are of a deep black-red colour, sometimes disposed in groups, sometimes isolated, and occasionally on the same leaf as those of the first kind. The colour of the larva is a reddish brown. The first shell-like coverings are little transparent, and in many parts quite opaque and dark brown. Its form is remarkably like to that of one valve of a cockle-shell. (Fig. 5.) The apex or hinge is always well attached to the leaf. As the insect grows, the digestive or secretory functions seem to be more perfectly performed, and the material of the covering become of a rich canary-yellow colour, and very translucent. The shell of yellow lerp varies in diameter from one third to one half of an inch.

The strong threads all rise from near the point of attachment, which is at the cleft of the heart-shaped base, and arching over meet the leaf.

Around this fixed point the leaf is always more or less dried up and discoloured. A thick tuft of curling hairs rises from the neighbourhood of the apex. The finer striæ, which are disposed parallel to the surface of the leaf, and line the roof, are quite distinct and separate from each other. Around the base is a broad flat band of an open reticulated texture. A white filmy carpet, composed of extremely fine threads crossing in all directions, completes the interior of this beautiful structure. The pupa and perfect insect are twice as large as those which fabricate the white lerp.

The head and thorax are more highly coloured, and the abdomen of a warmer green. (Fig. 6.)

The elytra and wings are diaphanous, but the wing-cases of the pupa, and the elegant symmetrical nervures of the elytra of the perfect insect, are of a bright scarlet colour.

[Under each of these limpet-like coverings there is usually found one or two little drops of a thickish, nearly transparent, and sweet fluid, like honey, deposited there no doubt by the insect after enclosing itself, to become a resource probably in case of protracted imprisonment from any unfavorable state of the season as to temperature, humidity, &c. The insect would appear to be very susceptible to changes of temperature, and perhaps to atmospheric influences generally; for I have observed that, when a twig having leaves, with the white cones plentifully scattered over them, is brought in and kept for a few hours in a warm apartment, the perfect insects disengage themselves and are seen to flit about in numbers. —J. M.]

The foregoing Paper, which was originally read before the Royal Society of Van Diemen's Land on the 11th of September, 1850, and published in the 'Papers and Proceedings' of that body, Vol. i, part iii, p. 235, was brought before the Microscopical Society by Mr. Dobson on the 30th of April, 1856, and he at the same time exhibited numerous and well-preserved specimens of the yellow variety of Lerp, a form which appears hitherto to have been undescribed. The variety examined and described by Dr. Anderson ('Edinb. New Philosophical Journal,' July, 1849) was of the white kind, and, as it would now appear, the product of a distinct species of *Psylla*. To Mr. Dobson, therefore, is due the credit of describing three distinct species of *Psylla* and two additional forms of lerp, and of ascertaining, beyond doubt, the correctness of Mr. Newport's surmise that the substance itself is produced by the insect, and is not a mere exudation of the plant. Mr. Newport, however, seems to have been ignorant of the true position of the insect by which this production is afforded.

The comparative novelty of the subject, and the importance of Mr. Dobson's communication, which appears hitherto to have wholly escaped the notice of entomologists in this country, appear to afford sufficient reason for the republication of his Paper in the 'Transactions of the Microscopical Society.' The figures, with the exception of figs. 8 and 9, are taken from those given in the original paper. The two additional figures were prepared from specimens of yellow lerp, kindly afforded to Mr. Busk by Mr. Dobson for examination.

In this examination the points to which attention was more particularly directed were—

1. The structure of the yellow conical crusts.
2. The chemical reactions of the substance of which they are composed.

1. The general appearance of the crust is that of a more or less conical dome, the apex of which is usually excentric. The surface is covered with long, shaggy, hair-like fibres, and the whole is of a canary-yellow colour and brilliant appearance, like that of spun glass or sugar. The cup is very loosely attached to the inferior surface of the leaves of a species of *Eucalyptus*, and the substance is very brittle. A portion placed on the tongue affords a sweetish taste.

The texture of the crust, examined under a low power, very closely resembles that of the sugar-baskets made by confectioners, and the mode in which it is constructed would appear to admit of explanation upon the supposition that the larva throws out loop over loop of a glutinous material much in the way that an artist in glass constructs his fragile toys (fig. 8). The insect, however, follows a definite plan in its operations; for the edge of the limpet-shaped crust is pretty regularly dentated, the dentations being all very nearly of a length. From the point of each dentation two divergent branches arise, which meeting with those springing from the adjoining dentations, a second dentation opposite the interval between those of the former row. In this way more or less regular reticulations are formed, across which slender threads of the same substance are drawn in the most irregular manner. This structure is also shown in fig. 8. The older or more central part of the dome is thickened by subsequent deposition, and the interstices in this way become nearly filled up. The outer surface of the cone is beset with numerous long, curved, hair-like processes of a very curious conformation, and one not very easily accounted for. Each hair, which in length may equal the semidiameter of the cone, arises abruptly from one of the thicker trabeculæ, and is of pretty uniform diameter throughout. Its surface, however, differs very remarkably in different parts. Towards the point (fig. 9 *a*) it presents a moniliform appearance, and is otherwise smooth and polished; and in this part it is usually somewhat compressed. This condition exists for about one sixth of the length of the hair. In the remaining portion the surface is marked by fine longitudinal

crenate ridges (fig. 9 *b*), which present a beautiful appearance under the microscope. The hair is apparently solid and homogeneous throughout, and certainly not tubular as stated by Dr. Anderson.

2. With respect to the chemical composition of the crust, it would appear, from the action of reagents, to present all the properties of pure *starch*. It is turned blue by iodine, is unacted upon by cold water, and with difficulty dissolved in boiling water, and then not wholly, a sort of membranous residue being left as in starch grains. Alcohol and ether in the cold have no effect upon it. The sweetish taste perceptible when a portion of lerp is placed upon the tongue may probably be due to the rapid conversion of the amyloid substance into sugar, under the influence of the saliva.

In the Paper by Dr. Anderson, above referred to, a more complex composition is assigned to this substance. But it is not improbable that the samples of lerp operated on by that chemist might have undergone some change, and thus have contained more highly oxidized compounds than appear to exist in the unaltered crusts. One thing is perfectly certain, that the entire substance is coloured blue throughout, and homogeneously, by a watery solution of iodine, and that in *cold* water no change whatever is effected in it. Dr. Anderson's statement, moreover, that starch grains, in the usual sense of that term, are contained in lerp, does not accord with our observations either upon the white or yellow kinds. The substance, in short, appears to be constituted of a homogeneous amyloid substance which, from its morphological characters, would seem to be spun out of the body of the larva in a semifluid or glutinous condition, and afterwards to harden into the transparent vitreous substance of which the crusts are composed.

Dr. Anderson states that the lerp (white) examined by him consisted of—

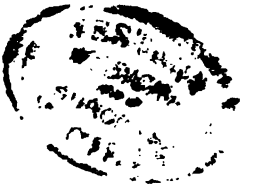
Water . . .	15·01
Sugar (grape) .	49·06
Gum . . .	5·77
Starch . . .	4·29
Inulin . . .	13·80
Cellulose . .	12·04
	100 00

The fact that many species of *Psylla* and other homopterous insects afford starchy and sugary secretions is notorious, though no very precise chemical examination of most of these substances appears hitherto to have been made. A familiar instance of the kind is presented in the *Honey-dew*

of the *Aphis*, a genus very closely allied to *Psylla*. The larva of *Psylla Betulæ*, according to Mr. Curtis, and of other species of the same genus, is covered with a white cottony secretion, and their excrement (as it is termed) is said to form threads or masses of a gummy sucreous nature. But an observation most to the point as regards the present subject occurs in the 'Mémoires pour l'histoire des Insectes' of the illustrious Reaumur (tom. iii, p. 357, pl. 29). In his description of *Psylla Buxi*, he says, "Il parait porter au derrière un morceau de vermicelli, dont la figure a été mal moulée, car la couleur comme la figure de cette matière ressemble assez a celle de la pâte filée appellée *vermicelli*." He notices further that "il sort de l'anus," and that it dissolves on the tongue, having a taste "un peu sucré et qui est agréable; c'est un espèce de manne qui n'a pas les désagrémens de la manne ordinaire." He observes also, that there would be no difficulty, in many places, in collecting this sort of sugar in considerable quantity.*

In conclusion, it may be remarked, that the "Lerp" would appear to be a substance well calculated to form a substitute for sugar or malt in distillation. It would seem to occur in sufficient quantity to render it worth collecting for such a purpose.

* Appended to this account of *P. Buxi* is a figure of the larva, in the act of manufacturing the *vermicelli*, which so closely resembles the central larva in fig. 2 that the latter might almost be deemed a copy of it.



MICROSCOPICAL SOCIETY.

February 11*th*, 1857.

George Shadbolt, Esq., President, in the Chair.

This being the annual general meeting of the Society, the following Reports of the Council and Auditors were read:

"The Council in accordance with their usual custom have to make the following report on the progress and present state of the Society.

"The number of members reported at the last anniversary was 241, including two associates and two honorary members; since that time 30 ordinary members have been elected, making a total of 271. This number must, however, be reduced by three deceased and one resigned, leaving a final total of 267. The Council have, therefore, to congratulate the Society on the steady increase of the number of its members. The library has been increased by various donations; but with regard to the collection of objects, the Council have to express their regret that but one addition is recorded to have been made to that important department of the Society's property, and trust that on the next occasion they shall be enabled by the liberality of the members to present a more favorable report.

"The Auditors' Report, which follows, gives the state of the finances, which the Council are happy to state appear to be in a prosperous state, the balance in the treasurer's hands being £51 16*s*. 9*d*., an increase of about £21 on the last year's balance.

"The 'Journal' has been distributed gratuitously as usual, and arrangements have been lately made by which it is expected the members will be enabled to receive it as it may be published in a more satisfactory manner than heretofore."

Dr. From FEBRUARY 27, 1856, to FEBRUARY 11, 1857. **Cr.**

		£	s.	d.
Balance from the previous year		37	14	4
For entrance of members		54	12	0
Compositions (which have been invested) as per contra		21	0	0
Annual payments—				
For 1854	2 2 0			
1855	11 11 0			
1856	24 3 0			
1857	127 1 0			
1858	5 5 0			
		170	2	0
Copies of 'Transactions' sold, deducting commission and advertising		3	9	6
Two dividends on 3 per cent. consols to January, 1857		10	4	2
		£297	2	0

	£	s.	d.
By Rent of room, one year	30	0	0
Salary of Curator	4	4	0
Assistant-Secretary	21	0	0
Stationery, postages, carriage, &c.	10	2	10
Ray Society	1	1	0
Commission to Collector	12	5	6
Purchase of consols	20	0	0
Transactions	91	2	0
Printing (Newman)	9	16	0
Repairing microscopes	4	7	0
Expenses of soirée, gas, oil, and attendances	34	6	11
	238	5	3
Balance	58	16	9
	297	2	0

11*th February*, 1857.

M. S. LEGG, W. H. INCE, } *Auditors.*

The President then delivered the following address. .

The President's Address *for the year* 1857.

By George Shadbolt.

Ever since the formation of the Microscopical Society, it has been the undeviating custom for the president at each recurring anniversary, to present to the members a species of intellectual balance sheet, or rather profit and loss account of the acquisitions to microscopical science during the past year.

It is not without some considerable diffidence that I enter upon this duty, especially retaining, as I do, a vivid remembrance of the masterly and comprehensive productions of my immediate predecessor in this chair, Dr. Carpenter—a gentleman pre-eminently qualified for such a task; but as the performance of it by the individual who has the honour to fill the presidential office for the time being is imperative, I shall proceed to do so to the best of my ability, without further hesitation, trusting to your indulgence for any shortcomings of which I may be guilty.

Since our last anniversary we have held as usual eight ordinary meetings, at which have been read *eleven* original papers, *one* repetition of a paper which had previously appeared in a colonial publication devoted to science, and *two* reports from sub-committees appointed by the Council to make special recommendations upon points connected with subjects upon which uniformity of system seems to be desirable. I cannot therefore consider that the session has been by any means a barren one, in quantity at least; neither will a close investigation of the quality of the matter afforded for our mental repast prove less satisfactory.

At all of the meetings, very animated and instructive discussions upon the subjects of the various papers have also taken place, and it is much to be regretted that the income of the society is not sufficient to permit of measures being adopted for securing a permanent record of much valuable information that is thus drawn forth.

It is true that at *two* of the meetings we were unsupplied with any paper, in consequence of illness in one case, and professional engagements in another, interfering to prevent the preparation of matter provisionally promised; but even under these adverse circumstances discussions upon subjects interesting to the followers of microscopical science spontaneously arose. It is manifestly impossible for the Council as a body to undertake the *manufacture* of

papers, as even if practicable, the quality of such productions under pressure would in all probability be of a very inferior character—it is to the members alone that we can look for such papers as are of general interest; the *raw material,* if I may so term it, in the shape of observations, exists in abundance, and requires simply recording upon paper to render it available as a source of much profit to all concerned.

I cannot refrain from remarking, that in transmitting an article to the 'Journal' alone, one source of fruitfulness is entirely disregarded; the mere reading of such in our society appears to communicate an impulse to the auditors to go and do likewise, which is further strengthened by discussion. But in order to obviate any inconvenience from the absence of communications at any of our future meetings, it has been decided by the Council, that at each one a *special subject of discussion* shall be announced from the chair, to be entered into at the *following assemblage;* and thus it is hoped that those interested in the subjects selected, will have some inducement not only to attend and bear a part in such consideration, but also to collect such facts that fall in their way, or may be able to educe, as are in any way connected with it.

Any papers that may be received will take precedence of the subject proposed; but should there be *no* papers the discussion will then be the special occupation of the evening.

It is hoped that by this measure, not only will an awkward hiatus be avoided, but that the various suggestions thrown out will tend of themselves to give rise to the production of more formal communications.

Of the eleven original papers read at the various meetings the classification is as follows, viz.:

On Animal Physiology	2
On Botany and Vegetable Physiology . . .	6
On Manipulation and Microscopic Adjuncts . .	3
	11

The two reports belong also to the latter class, and the paper alluded to as a repetition may be classed with the first named, making in all a total of 14.

I may also mention that in one of the papers classed amongst the botanical, certain speculations relative to geological science are included.

Of these relating to Animal Physiology, the first in order was from the pen of Mr. Bowerbank, "On the structure

and vitality of the Spongiadæ," consisting of the substance of some observations presented at the last meeting of the British Association, at Cheltenham, together with a considerable amount of new matter since ascertained. In this paper the author endeavoured to show that sponges consist principally of *sarcode*, strengthened sometimes by a species of siliceous or calcareous skeleton, having remarkable reparative and digestive powers—and consequently a most tenacious vitality.

As an instance of the singular powers of reparation, he mentioned that having sometimes cut a living sponge into *three segments* and *reversed the position* of the centre piece, after the lapse of a moderate interval a complete junction of the parts became effected, so as to render the previous separation indistinguishable.

This paper was not permitted by the author to appear in the Transactions of the Society, being still in an incomplete state, further investigations upon the subject being also in progress.

The paper by our respected secretary, Mr. Quekett, "On the white substance surrounding the Coccus infesting the Vine," contained, as might have been expected, many interesting observations, especially as regards the wax-producing organs of insects; but as our knowledge in this direction is still very rudimentary, I cannot forbear urging those who are in want of a *special* object for the exertion of their microscopic energies, to turn their attention to so promising a field for useful results.

Somewhat connected, as regards the subject, with the preceding paper, is that communicated by Mr. Busk—originating with Mr. Dobson, of Hobart Town, and previously published in the 'Proceedings of the Royal Society of Van Diemen's Land,'—On Laap, or Lerp, the cup-like coverings of Psyllidæ found on the leaves of certain Eucalypti." To this paper was appended some remarks and observations on the structure and chemical nature of the said coverings, by Mr. Busk, which that gentleman describes as closely resembling the sugar baskets made by confectioners, and consisting chemically of nearly pure starch, not indeed in a form in which that material is usually met with, but constituted of a "homogeneous amyloid substance," affording a sweetish taste when applied to the tongue, probably being converted into sugar under the influence of the saliva. Under the action of iodine and other reagents it comports itself precisely as ordinary starch; but the point of special interest appears to be the fact of its production by *animal* agency, and

though of course it is not unreasonable to conclude that it is primarily derived from the vegetable substances on which the animal feeds, its subsequent elimination in a form in which the chemical properties are persistent is somewhat singular.

As it appears from Mr. Dobson's observations that the substance occurs in *considerable quantities*, Mr. Busk suggests that it might be worth collecting for the purpose of using in distillation as a substitute for sugar or malt.

Amongst the papers classed under the head "Botany and Vegetable Physiology," the first that claims our notice is that by Dr. Gregory, Professor of Chemistry in the University of Edinburgh, "On the Post-tertiary Diatomaceous Sand of Glenshira."

This is a continuation of a paper commenced in the preceding year, containing a description of upwards of 200 known species of Diatoms, together with some twenty or more previously undescribed. The present one adds many more new species to the list, while that of the known forms is also extended, making a total of some 300 already observed in this gathering, unparalleled for richness of yield, and which the author intimates will require another paper to complete the description. It appears that about 600 slides have been carefully examined, a task, however delightful, that must have been intensely laborious; only those who have worked in this particular field can be fully alive to the amount of labour required.

Dr. Gregory is doing good service, not only in making us acquainted with new forms, but also in a point of equal importance, that of drawing attention to the *variations of form* occurring in the *same species*, in a similar manner to that adopted by our late president, Dr. Carpenter, as regards some of the Foraminiferæ. In fully working out a subject of the kind under consideration, it is not the larger and more striking forms (the most elaborate, if I may so term them) that occasion the greatest amount of labour, but the more minute and abundant ones, the οι πολλοι, where some ten or a dozen dissimilar forms, to the careless observer, appear as one species, until certain slight but constant peculiarities are discovered to predominate in some individuals.

In investigating the smaller Diatoms, especially those with minute markings, great assistance may be derived by using a *moderate* power and noting the peculiar colour assumed by the frustules, as was pointed out by Professor W. Smith. The colour being due not to any inherent dye, but to the well-known property of fine, close lines in producing appa-

rent colour by *interference of the undulations of the luminous rays;* hence the tint assumed is to a certain extent an indication of the mutual proximity or remoteness of the markings on the various frustules.

The next paper on my list is Professor Henfrey's "Notes on some fresh-water Confervoid Algæ, new to Britain," being descriptive accounts of the *Pandorina morum* of Ehrenberg, the *Apiocystis Brauniana* of Nägeli, and the *Clathrocystis æruginosa,* Henfrey = *Microhaloa æruginosa,* Kützing, which that observer can only have seen, as Mr. Henfrey considers, in a dried state, as it does not agree with Kützing's description of the genus referred to.

As might have been predicted, Mr. Henfrey's descriptions are careful and minute; he has, however, erred in classing *Pandorina morum* amongst the Algæ *new to Britain,* it being one that I myself, and I believe many other microscopists, have met with very frequently for the last ten years or more. Mr. Henfrey has, however, corrected the inaccurate account of the organization that was hitherto generally received.

It will be as well to consider the *three next* papers together, for though each has its distinctive peculiarities, they all bear closely upon the same important subject, viz., the early stages of the vegetable cell.

The papers are—"On the Vegetable cell," by Mr. F. H. Wenham; "Brief remarks upon Cell-growth in the *Bryonia dioica,*" by Mr. Norris F. Davey; and "Vegetable Cell-structure and its formation, as seen in the early stages of the growth of the Wheat plant," by the Hon. and Rev. Sidney Godolphin Osborne.

All of these papers tend to controvert the cell-theory of Schleiden and Schwann, so far as the doctrine of multiplication by self-division from unity is concerned; and from the careful observations made by Mr. Wenham on the *Anacharis alsinastrum,* an aquatic plant, *confirmed* by those of Mr. Davey on a terrestrial one—the *Bryonia dioica*—it is abundantly manifest that *simultaneous development* of many cells obtains, as one mode, at least, of increase. Of course it is not contended that increase by simple division does not take place, but that this is not the only, or, according to Mr. Wenham, the principal method of multiplication. When a somewhat startling statement is made by a microscopic observer, the first question which naturally occurs to the mind is this, Does he understand the manipulation of the instrument? and the next, Can he rightly interpret what he sees? Now every one who is familiarly acquainted with Mr. Wenham, must, without hesitation, answer both these ques-

tions in the affirmative; but we do not stop here—his observations, as far as facts are concerned, are confirmed by those of Mr. Davey, and to a great extent by those of Mr. Osborne. Of course much misunderstanding might arise in a question of this nature as to the true definition of a vegetable cell; but as my predecessor entered at length upon the question in his address last year, I cannot do better than recommend a re-perusal of that document, containing, as it does, a most lucid disquisition upon the subject.

I should have before remarked that Mr. Wenham's paper was partly in reply to some animadversions on his statements in a previous paper, and partly a continuation; while Mr. Davey's was confessedly the result of investigations upon a different kind of plant, undertaken with the special object of testing the accuracy of Mr. Wenham's revelations.

I have hitherto said but little respecting Mr. Osborne's paper; not because it is in any way contradictory to the theory promulgated by Mr. Wenham; on the contrary, strongly confirmatory of the same: but it actually describes the *simultaneous formation of numerous* cells from the protoplasm direct, not as an accessory, but as a prevailing mode of production in the embryo plant.

This admirable paper is one of the highest interest, characterised by acuteness of research, accurate illustration, and novelty of manipulation, the author having successfully introduced colouring matter into the cell-structure in such a manner as to reveal secrets in Nature's handicraft otherwise unattainable. Those who take a special interest in this much contested question would do well to refer to figs. 32 and 33, Pl. V, of the illustrations, and page 112 of the text, to see how positively Mr. Osborne affirms the simultaneous development theory.

As a finale to the papers belonging to this section, we have Professor Quekett's, "On Fungoid Growth in decayed and living wood." The author shows how much unsuspected injury to the timber may arise from broken branches, or injudicious pruning of trees, when the circumstances are such as to afford favorable conditions to the growth of fungi; and in many cases the thread-like fibres of mycelium can be traced permeating every part of the trunk and branches. An opinion was also expressed as to the cause of attraction to wasps, presented by hollow trees, being the dried whitish substance of the fungus alluded to, which, on examination, appears identical in structure with the material of which the cellular nests of these insects are composed.

The reading of the latter paper gave rise to some short

observations from our assistant-secretary, Mr. Williams, on a fungoid disease of the grape vine, as noticed by him some years previously.

In the manipulatory and mechanical department, we have from Mr. Wenham a paper "On a method of Illuminating Opaque Objects under *the highest* powers of the Microscope." This is a problem, the solution of which has been attempted by numerous adepts in manipulation with only very partial success, until Mr. Wenham accomplished it by means as ingenious as they are simple. Of course, with a one-twelfth objective, or any higher power, the use of a Lieberkühn is simply an impossibility, while a plane reflector, as previously suggested by Mr. Brooke, reflects the light too feebly to be of service in most cases; and furthermore, there is no very ready means of *intercepting the transmitted* ray when a plane reflector is used. Mr. Wenham's happy idea of making the *upper surface* of the *thin glass* covering of the object its own reflector, by *internal total reflection,* not only enables us to illuminate with the requisite brilliancy, but also renders available objects *mounted in balsam,* or some other medium, which would otherwise often be useless for examination by very high powers. The principle involved precludes the use of specimens that are mounted dry, for this method of examination; to those who are acquainted with optics the reason will be at once apparent; to those who are not the explanation would be tedious, and occupy more time than could be reasonably devoted to it this evening.

From Mr. Hislop we have been favoured with the description of a piece of apparatus for compressing objects while being mounted; and Mr. Farrants furnished a paper "On defining the position and measuring the magnitude of microscopic objects." This latter being a subject that has occupied the attention of many microscopists recently, it was thought desirable to appoint a committee to consider and report upon the best form of a *universal finder,* so that an object being noted by one operator, might readily be found by others, although by a different instrument and apparatus. The report of the committee will be found in the 'Transactions,' and fully carries out the conditions imposed.

The consideration of this question involved another point of scarcely less importance, or rather gave rise to its consideration; the desirability of inducing the various instrument-makers to adopt one uniform size and mode of attachment for objectives, so that they may be used upon various instruments indifferently without the aid of *adapters,* these being found to interfere very materially with the

correct performance of the higher powers especially. A satisfactory report upon this point also appears in our 'Transactions,' and I cannot but congratulate my brother-microscopists upon the prospective comfort we may shortly hope to enjoy in consequence of the adoption of its recommendation.

In considering the sum of our doings, one cannot help remarking that research upon vegetable far preponderates over that on animal physiology, which is somewhat noticeable when we consider the number of members attached to the medical profession upon our list; but we also perceive that there are some subjects in particular in which very much more might be done. I will indicate a few of these, in hopes of inducing some of our most zealous operators to enter into "pastures new." To begin with, there is a large class of marine productions known generally as *Nullipores*, of which very little else is known, or if known, not recorded—and offering a wide field for research. Again, amongst lichens, mosses, and the more minute cryptogamic forms, there is still very much to be done.

In entomological science we rarely have observations, and when these do occur, they are not often more than isolated facts; that is, not connected directly with any *systematic* inquiry into special matters of obscurity. In this science especially much good might be done by a careful examination of all species known under the general name of *blights*, for though *much* concerning them may be known to entomologists, I am convinced that there is *much more* that still remains unknown, and is likely so to remain without microscopical aid. And lastly, during the forthcoming spring, I would urge upon those members whose special study lies amongst the Desmidiæ, the great interest attaching to the subject of the development of these Algæ from their spores, a phase in their history still involved in considerable obscurity.

I have to mention the names of three of our members who have been removed from amongst us by the hand of death, viz.—F. J. Bell, F.G.S., E. Allcard, F.L.S., and George Gwilt, F.S.A., &c., of whom the two latter were members at the original formation of the society. Mr. Gwilt, besides being an accomplished scholar, was an architect of no mean pretensions, an astronomer, an archæologist, and deeply versed in the science of numismatics.

As regards the progress of microscopical science, its great importance as an accessory in all branches of natural history, in medical jurisprudence, anatomy, geology, &c., is all but universally acknowledged; hence the rapidly increasing num-

ber of our members, which now amounts to 267, being 26 more than at the corresponding period of last year; while the large number of superior instruments sent out by our three most celebrated opticians, viz., Messrs. Powell and Lealand, Andrew Ross, and Smith and Beck, during the past year, testify to the fact that *quality* is in equal estimation with quantity.

The *three* makers just named have supplied, during the past year, no less than 217 instruments of the higher class; whilst the last-mentioned firm has *also* sent out 175 educational microscopes, of which 60 only were of their cheapest kind, making a total of no less than 392 instruments fitted for accurate scientific investigation.

But even this number, large as it is, does not comprise the whole, or anything like the whole, of those that may fairly be classed under this category; for there are now in London alone several makers who, though they may not as yet attain to the excellence of those already quoted, are treading so closely upon their heels, that the productions of those in the *second rank* closely approach those of our first makers *as they were some few years ago*. Consequently, to comprehend the entire quantity of real working microscopes put into circulation for the last twelve months, we should add those supplied by Mr. Salmon, Mr. Amadio, Mr. Ladd, M. Pillischer, and some others. The four makers quoted have collectively issued 115 of the large instruments, and 243 students' and medical microscopes; consequently this number, added to the 392 previously quoted, gives us a total (a *mininum* total) of 750 brought into operation in one year; for there are doubtless some not included in this list,—and be it understood that the whole of these were effective, working instruments. Surely this plentiful sowing ought to make us reap plenteously.

With such exquisite microscopes as we have been for the last few years in the habit of using, anything like improvement might almost be regarded as "gilding refined gold;" yet progress has been made even here, and still the cry is "Excelsior."

Messrs. Powell and Lealand have made an objective of *very high quality*, equivalent to $\frac{1}{16}$ inch of focal distance, of very large aperture (alleged to be of 175°—but of this hereafter)—which for performance is deserving of the highest praise.

Mr. Ross has constructed a $\frac{1}{8}$-inch object-glass of 140° angular aperture, having that great desideratum, a *reasonable distance from the object under observation*, and that possesses

very fine defining quality, uninjured by *an extraordinary* amount of power in the eye-piece.

Mr. Thomas Ross has also effected a *considerable* increase in the apertures of the lower powers, having availed himself of the advantages to be obtained from the various qualities of glass which can now be procured, together with certain facts developed during his researches connected with the improved construction of lenses for photographic purposes.

The aperture of the $1\frac{1}{2}$-inch objective now extends to 20°, while the 3-inch, 2-inch, 1-inch, and $\frac{2}{3}$-inch have a corresponding increase, and all bear well the very severe test of an unusually powerful eye-piece, thus also affording to the microscopist an additional range in the choice of amount of amplification.

Messrs. Smith and Beck have also extended the aperture of their $1\frac{1}{2}$-inch objectives from 14° to 20°.

I have also had the pleasure of examining, with great care, two object-glasses of high power, constructed by a gentleman to whom microscopists are deeply indebted, who has not only favoured us with the result of important investigations relative to vegetable development and other subjects, but who has done more to stimulate the professional opticians to elevate the standard of excellence, as regards their manufactures, than any other microscopical devotee. I allude to Mr. F. H. Wenham, whose absence from our gatherings, though only temporary, is a source of regret to many. Mr. Wenham's mechanical skill and persevering industry, conjoined with an ardent zeal for the prosecution of science generally, have enabled him to compete successfully with our first makers; and the two object-glasses in question are such as would be coveted by the most fastidious. The one is about equal to $\frac{1}{14}$ inch focus; the other, according to my calculations, about $\frac{1}{20}$, though the artist himself calls it $\frac{1}{25}$; but be this as it may, with an aperture of only 150°, its performance is of the very highest order and beyond all praise.

In both of these lenses, Mr. Wenham has adopted a variation upon the usual method of adjustment for thickness of glass covering to the object, which, in my opinion, deserves imitation by our professional opticians. The improvement I mean consists in *two points*, viz., in causing the *back combinations* of the lens to be the moveable portion instead of the front as is usually constructed; and secondly, in allowing the motion to be more rapid, the whole movement of which it is capable being effected by a quarter turn of the collar. Thus constructed, the requisite adjustment can be made with greatly increased facility, and, with the

assistance of the ordinary fine adjustment, *without losing sight of the object under examination* during the operation, an amount of convenience not to be credited but by those who have worked with both kinds of objectives.

From the remarks that I have made upon aperture, it will be perceived that I differ materially from my predecessor in my appreciation of this element of utility in a microscopic object-glass.

It is perfectly true, as stated by Dr. Carpenter, that with an objective of *large* aperture the perfection of its delineation is more confined to *one plane*, and that consequently a *general view* of the object under consideration cannot be so well attained; and secondly, that the manipulation is much more difficult with an extended than with a contracted aperture.

The very delicacy of one's tools of course demands an extra amount of skill in their use; but is it not possible to unite the advantage of a large aperture with the convenience of a moderate one in *the same object-glass?* To this an affirmative reply may be given; for I have in my possession objectives made for me by Messrs. Smith and Beck, with a diaphragm removeable at pleasure, so that for objects requiring aperture for their definition, that quality is attained with the most trifling amount of trouble to the manipulator, while for general use the aperture is contracted within moderate limits. Of course such a construction, to be effective, involves the proper correction for *large* angular aperture, in which case the lens will perform equally well when it is temporarily reduced. Messrs. Smith and Beck have fitted object-glasses in a similar manner for others besides myself, and I cannot but think it would be a great convenience if the higher powers especially were usually provided with this adaptation.

A comparatively large aperture in the lower powers is useful in two ways, both in consequence of the extra amount of light transmitted, first, in examining *opaque* objects, which with such lenses scarcely require any aid from a condensing lens for illumination; and secondly, the flood of light permitting the use of greater power in the eye-piece without too much reduction of brilliancy of the image, thus allowing, for a given amount of magnitude, the use of an objective of lower power than would otherwise be requisite, and consequently, what is sometimes of importance, a greater distance between the object and the lens.

While on the subject of aperture, I cannot refrain from remarking, that I am convinced that in many cases *some considerable error* has been committed in the measurements

taken. To satisfy any one of this, it will only be necessary to look at the size of the *front lens* of a $\frac{1}{12}$ or any higher power, when it will at once be evident, by a very simple calculation, that for such a lens to refract a ray of light incident upon it at such an angle as will produce an aperture of 175°, the lens itself must be in *absolute contact* with the object, and no allowance made for the most trifling amount of *fitting* to hold the lens itself in place.

I may remark also, that some of the most marvellous statements made as regards enormous aperture, have been attached to lenses produced on the other side of the Atlantic Ocean; but I am quite unable to ascertain anything approaching to a verification of such statements; and while I know of *several occasions* when special arrangements have been made for comparing the merits of English and American lenses of the highest character, I am unaware of any instance in which the former were worsted; for it has always so fallen out that some untoward event has prevented the actual comparison from being carried out, *though English* lenses have been ready, and English operators eager for the contest.

It is, however, high time for me to pause; I fear, indeed, that a subject so congenial as the optical qualities of our favorite instrument has already seduced me into trespassing too long upon my auditors' patience.

I have to express my great regret that as regards our collection of *objects*, we have the very insignificant number of 340 only—a number that would be regarded as small indeed by *many*, if not *most*, of our members for their own collection. Surely then, as a society, this ought not to be, and I trust that the mere mention of the fact will be enough to cause this reproach to be speedily wiped away.

In conclusion, therefore, let me express a hope that our members will not forget that it is to themselves alone that we look for the means of sustaining the interest of our future meetings.

The Society then proceeded to the election of officers and council for the ensuing year, when the following alteration in the bye-laws was resolved upon, viz.:

That in page 6 of the regulations of the Society, the following alteration be made in the sixth line from the top: instead of the word Secretary, the words "two Secretaries" be inserted, and that in the succeeding regulations the corresponding alterations be made where necessary.

It was afterwards resolved—

That George E. Blenkins, Esq., be proposed as Joint Secretary with Professor Quekett, in accordance with the before-mentioned alteration in the laws.

At the close of the ballot, the following names were announced from the chair, as having been duly elected to their several offices for the ensuing year:

President—George Shadbolt, Esq. *Treasurer*—N. B. Ward, Esq. *Secretaries*—Professor Quekett; George E. Blenkins, Esq.

Four Members of Council—T. H. Huxley, Esq.; E. G. Lobb, Esq.; W. Peters, Esq.; J. H. Roberts, Esq. In the place of Dr. L. Beale; C. Brooke, Esq.; J. N. Furze, Esq.; Dr. Lankester; who retire in accordance with Rule VII.

The Rev. T. Wiltshire, M.A., Rectory, Bread Street Hill; Dr. Cobbold, 27, Upper Seymour Street; James Wyatt, Esq., Coldstream Guards; James Macgregor, Esq., 55, York Terrace, Regent's Park; Joseph Moore, Esq., Grasmere Lodge, Lower Tulse Hill; were balloted for and duly elected members of the Society.

The meeting was then adjourned to a soirée, at which about 350 persons were present.

On a Diatomaceous Deposit *in* Leven Water, *near* Coniston. By Amos Beardsley, F.L.S., F.G.S., &c.

(Read March 4th, 1857.)

Leven Water is a mountain tarn, a large sheet of water embosomed in the rocks to the north of Coniston Old Man. When full it covers a surface of about eighty acres, and is about twenty fathoms deep. The rocks surrounding this tarn are chiefly composed of hornstone, porphyry, and trap. It is about 1300 feet above the sea-level. The mountains surrounding are for the most part on the north, north-east, and west sides. When visiting this water, in company with some friends, I observed the bottom of it to be entirely covered with a blackish pulverulent deposit, and from a careful examination on different sides of the lake, I found that this deposit extended all round, and though of various thickness, yet in every part it was some two or three feet thick, whilst in others I ascertained it to be six or eight feet. It appeared to be thickest in the vicinity of the rills or streams that, flowing down the mountain sides, empty themselves into the lake. Suspecting this deposit, from its appearance, to consist chiefly of diatomaceous remains, I brought a little of it home, and subjected it to the microscope, and was highly gratified to find that I was correct in my supposition. I have supplied various friends with portions, and all have been pleased with the many forms it exhibits. It is not brought under the notice of the Society as at present having yielded any new species or varieties of diatoms; still it appears to be interesting, as affording a good instance of how a deposit is now forming of considerable thickness, and which may throw some light upon the manner in which other and older deposits have been left.

The Diatomaceæ here found have undoubtedly grown on the sides of the mountains around the lake, and been washed down by the rains, &c., by the rills and streams into the lake, where they have accumulated for ages. I am informed by Mr. Barratt, of Coniston, that the bank which is across the south end of the lake was made about twenty years ago to retain the water for the use of the copper-mines which are in the vicinity, but that two or three years ago the lake was "tapped" twenty-one feet deeper, so that it can now be drawn off to a depth of forty feet. When I visited it the lake was low, and therefore close to the margin, and some feet above it, this deposit was exposed, which probably would not be noticed if the lake were fuller.

I subjoin a list of the Diatomaceæ, which has been kindly supplied me by Professor Smith, of Cork, as the species he has detected in a specimen I forwarded to him for examination. I have little doubt but that many more forms will eventually be observed in it, and from the elevated position at which the deposit occurs, it includes those species which are mountainous, or subalpine chiefly; and in looking over the list, as supplied by Professor Smith, it will be observed that many species are named which have also been found in high Alpine regions.

Observations as to the localities of Diatoms are as yet too contracted to generalise from, still there appears ground for the belief that particular forms are peculiar to different altitudes, and that altitude rather than other causes will give variety of species.

LIST FORWARDED BY PROFESSOR SMITH.

DIATOMACEÆ IN LEVEN WATER.

Eunotia tetraodon.
diadema.
bidentula.
Cymbella Helvetica.
Navicula serians.
rhomboides β.
Bacillum.
crassinervia.
forina β.
Stauroneis anceps.
gracilis.
Pinnularia gibba.
interrupta.
interrupta β.
acuminata.
gracillima.
mesolepta.
lata.
Surirella biseriata.
linearis.
Gomphonema dichotomum.
tenellum.
Synedra biceps.
Nitzschia curvula.
linearis.
Himantidium bidens.
pectinale.
undulatum.
majus.
majus β.
gracilis.
circus.
Achnanthidium lanceolatum.
Tabellaria florealosa.
fenestrata.
Fragilaria undata.
capucina.
Melosira nivalis.
Odontidium mesodon.
hyemale.

[*Note.*—Accompanying the above paper was a packet of the deposit described, kindly forwarded by the author for distribution among the members of the Society; and with it an intimation of his readiness to afford a further supply to any member desirous of receiving one.—EDS.]

On the Organs *of* Cutaneous Respiration; *principally on those of the* Rana temporaria. By George Harley, M.D., F.C.S., Teacher of Practical Physiology and Histology in University College, London.

(Read March 4th, 1857.)

The theory of cutaneous respiration is now regarded as an established doctrine. Among some of the lower animals the interchange of gases by means of the skin is performed in so perfect a manner as to be in itself capable of supporting life. Bischoff, and other observers, found that even certain Batrachia live during several hours after the extirpation of their lungs; the aeration of the blood being accomplished by the cutaneous surface alone. The peculiar function which the skin possesses of absorbing oxygen, and exhaling carbonic acid, is not confined entirely to animals low in the scale of development; it has been traced throughout the whole animal kingdom. Experiments performed on the human subject by Scharling, Valentin, Brunner, Andral, and a great many others, have clearly demonstrated that even the cutaneous surface of man has an important share in the respiratory process. As far as I am aware, however, no one has attempted to describe the construction of the apparatus by which the interchange of gases takes place. The following observations may perhaps therefore prove interesting, from the simple fact of their novelty.

Several months ago, while studying the physiology of cutaneous respiration, I was desirous to ascertain if the skin possessed special organs for the aeration of the blood. With the human skin, however, I found it impossible to arrive at any satisfactory conclusion, and therefore directed my attention to the examination of the skins of animals possessing a more highly developed cutaneous respiration. The frog being easily obtainable, and at the same time well suited for the investigation of this subject, was first examined.

On placing under the microscope a small portion of the epidermis from the back of the animal, the immense number of openings in it immediately arrested my attention. And on examining these openings more narrowly, I found, that what I had supposed to be the mouths of the organs usually designated cutaneous glands, possessed a remarkable resemblance to the stomates of plants.* Each opening appeared

* The observations related in the following pages were made in 1855, and in the latter part of that year I showed the peculiar openings in the skin of the frog to Professors Sharpey and Ellis, and several other gentle-

to be covered with a layer of epithelium cells, and in their centre could be distinctly seen a small aperture not unlike that observed in some stomates. The question at once presented itself, "May not these organs in the skin of the frog which so strikingly resemble the respiratory organs of plants, have a similar function to perform?" Dr. J. Davy* has pointed out that the pulmonary arteries of some of the Batrachia divide into two branches, one of which goes to the lung—the other, very little smaller, to the cutis, and is extensively ramified among the follicles. The veins rising in this position are said to convey back arterial instead of venous blood. Before entering into the consideration of this question, I shall first as briefly as possible describe the structure of the organs alluded to.

It being very difficult to detach the epidermis from the cutis vera of the frog's skin in the ordinary way, I put the body of a frog recently dead into water at a temperature of about 80° or 90° cent.; in a very few seconds the hot water induces a state of rigor caloris which lasts from twenty-four to seventy-two hours; after a short immersion the animal is transferred to a vessel containing cold water, and kept there during several hours. The epidermis gradually detaches itself from the cutis vera, and can be very readily peeled off. A small portion obtained in this manner, when examined with a power of about 70 diameters, looks like a fenestrated membrane. It is seen to be pierced by a great number of openings varying in size from $\frac{1}{30}$ to $\frac{1}{10}$ mm. in diameter, and of a more or less rounded shape, as represented at Pl. VI, fig. 2. These openings are of so considerable a diameter that if the preparation be held between the observer and the light, they are distinctly visible to the naked eye. When magnified with a high power of 200 or 300 diameters, they are seen to be covered with a layer of tesselated epithelium, which is apparently continuous with the most superficial layer of the epidermis. Each of the tesselated epithelium-cells constituting the covering has a well-marked nucleus (Pl. VI, fig. 1), and in the centre of this layer or near it is a cell, differing somewhat in shape from the others, in being rounded, while the rest are more or less polygonal. The circular cell differs still further from the others in having a small aperture instead of a nucleus; it measures on an average $\frac{1}{60}$ mm. in

men, as I imagined at that time that I was the first who had observed them. Since then, however, I have found that the honour of their discovery belongs to Dr. Ascherson.

* 'Researches, Anatomical and Physiological,' vol. i, p. 111.

diameter. The small aperture is of a peculiar triangular form (Pl. VI, figs. 1, 3), as described by Ascherson,* seventeen years ago, not at all unlike the shape of a leech-bite. On examining this aperture minutely (which is easily done with a portion of the superficial layer of epithelium detached from the rest of the epidermis), its sides are found to form three small triangular flaps, or valves, which by their juxtaposition completely close the opening. In some specimens the valves are retracted, and the little gateways appear wide open; the patulous condition of the apertures is, however, not the one most usually observed. Mr. Huxley† has described the trifid apertures as being disposed between three epidermic cells, and not as a peculiar structure in the centre of a cell differing in shape from the others forming the epidermic covering of the skin. I have examined this point very carefully, and it appears to me that this gentleman has erred in supposing that the triangular opening is disposed between three epidermic cells; had he examined the most superficial layer of the epidermis detached from the rest, he would easily have detected the peculiar circular cell with the opening in its centre. It may here be remarked that, if the epidermis in connection with the cutis vera, be placed under the field of the microscope, it is exceedingly difficult to distinguish the superficial layer, and next to impossible to detect the aperture in the central cell. The observer would do well, therefore, in his examination of these structures to follow the plan given above.

If the most superficial layer of the cutis vera of the frog be examined with a low power, it is seen to contain, like the epidermis, a number of perforations, which, by transmitted light, resemble so many windows in a dark ground (Pl. VI, fig. 5). Some of the windows appear as if partly closed by a curtain, while in others the occlusion is complete. The curtain, I presume, is nothing more than a portion of the lining membrane of the passage, accidentally detached in tearing away the epidermis, &c. The passage just spoken of is narrower at its mouth than at its base. It leads a short way into the corium, and then abruptly ends in a blind sac.

Dr. Ascherson, in the paper already cited, says that, on making a transverse section of the skin, he failed to detect any duct leading from the cavity in the cutis vera to the triangular aperture on the surface of the epidermis, although

* Müller's 'Archiv,' 1840, p. 15.

† Article "Tegumentary Organs," Todd and Bowman's 'Cyclopædia of Anatomy and Physiology,' p. 500.

he had little doubt that some channel of communication existed between them. Mr. Huxley, in his able article just quoted, has given a diagram in which the canal leading from the triangular mouth to the cutaneous gland is represented as a very small tube, with a diameter not greater than that of the trifid opening. In the specimens of skin which I have examined, the canal was very wide, in fact it seemed to possess the same diameter as the large opening, seen on the surface of the epidermis, covered with epithelium. The minute triangular aperture appeared to me to be only a small door opening into a wide passage, which passage conducted directly into the cavity beneath. I imagine it possible that Dr. Ascherson failed to detect the canal, in consequence of his searching for a fine duct having a diameter equal to the trifid aperture, instead of one equal to the large perforation in the epidermis.

I have carefully searched for a fine tube as represented by Mr. Huxley, but have not yet been able to detect the slightest trace of one.* At first sight, the size of the duct appears to be a matter of secondary importance; but when it is remembered that we are at present attempting to deduce a knowledge of the function from the peculiar structure of the organ, it is at once observed to be a point of considerable moment. A small tube, although answering admirably for the transpiration of liquids, would greatly retard the free interchange of gaseous fluids. When we have minutely considered the peculiar structure of the cutaneous follicles in the skin of the frog, we shall next attempt to show in what manner they differ from the ordinary forms of sudoriferous glands, and how they would seem to be constructed for performing the function of cutaneous lungs.

The outline, as well as the relations of this passage and terminal cavity, can be tolerably easily studied in a transverse section of a portion of skin which has been preserved during a few days in a solution of chromic acid. Such a section is represented at Pl. VI, fig. 6. The size of the cavities varies very considerably; some are nearly twice as large as others. They are lined with a layer of tesselated epithelium, the nuclei of which, on the addition of acetic acid, come distinctly into view. Some of the cavities appear empty, or contain, as previous observers have said, only a clear fluid; while others are full of a matter somewhat resembling mucus.† The wide

* Since this paper was in type I have found that Dr. Hensche noticed that the duct was wider than the orifice. 'Zeit f. Wiss. Zool.' vol. vii, p. 276.

† Hensche states that they contain 30—40 or more polyhedral cells. These cells were probably those of the epithelial layer lining the cavity.

spherical portion of these bottle-shaped organs, which lies in the cutis vera immediately under the pigment layer, is surrounded by a number of blood-vessels. When the blood-vessels are injected, they are seen to be congregated in the immediate vicinity of the cavities, and sparingly distributed throughout the intervening spaces. In this respect their arrangement bears a striking resemblance to the distribution of vessels round the gland-follicles in the skin of the toad, so beautifully delineated by Mr. Rainey,* and by Eckhard. The bottle-shaped cavities in the frog's skin are not, however, to be confounded with the large gland-follicles of the toad. They have little analogy to each other, and Mr. Rainey has even gone so far as to say that "no organs like those which I have described as the cutaneous follicles of the toad, exist in the integument of the frog or water-newt." On the other hand, however, the organs which it is the purport of this communication to describe, are to be found in the skin of the water-newt. Some even exist in the corium of the toad, but they are much less numerous, and are situated between the true gland-follicles spoken of by Mr. Rainey. Immediately beneath and partly around the blind sacs exists a layer of parallel bands, which compose the greater part of the true skin of the frog. These bands have been described by previous writers, and consists of two sets,—one running parallel to the skin, another perpendicular to it.. In consequence of the latter constricting, or, more properly speaking, binding together the longitudinal bands, a transverse section of the skin presents a wavy appearance (Pl. VI, fig. 6).†

The perpendicular bands are described by Ascherson as dividing the cutis vera into small quadrilateral fields, which he at first imagined to be cavities, until, on adding iodine, he found them full of solid matter. He does not appear, however, to have noticed the existence of the parallel fibres. Czermak,‡ on the other hand, observed not only the perpendicular, but also the longitudinal bands. He speaks of the former as being a set of tubes or canals leading from the under to the upper surface of the skin, and of the latter as consisting of bundles of areolar tissue. With neither of these views am I inclined to coincide, for it appears to me that the structure of the perpendicular, as well as of the parallel bands, in some respects resembles that of smooth muscular fibre, although

* "On the Structure of the Cutaneous Follicles of the Toad," 'Quarterly Journal of Microscopical Science,' vol. iii, p. 257.

† Müller's 'Archiv,' 1841.

‡ "Ueber die Hautnerven des Froches," Müller's 'Archiv,' 1849, p. 252.

it differs from it in the absence of nuclei, and the very slight tendency to split up into spindleform bodies. The bands cannot be said to consist of fibrous tissue, for they are very broad, and not separable into fibrils. Neither are they made up of the ordinary areolar tissue, for they swell but very slightly on the addition of acetic acid. They greatly resemble the elastic fibres in cartilage, and behave towards reagents in a somewhat similar manner. That they are elastic one cannot doubt; for the skin, of which they compose the greater part, is very elastic. If Professor Ellis's views regarding the structure of non-striated muscles be correct, namely, that they are not made out of nucleated cells, as Kölliker supposed, but are formed of bundles of fibrils or threads, with nuclei distributed here and there on their surface, I should incline to the opinion that these bands are a peculiar form of non-striated muscular fibre; and I should consider their not splitting into cells, each containing a separate nucleus, additional evidence in favour of Professor Ellis's opinion. Without wishing to enter into the discussion lately raised by Professors Ellis and Thomson, and Mr. Lister, regarding the structure of non-striated muscular fibre, I may say that the whole subject appears to me to resolve itself into the single question, "Are the bodies described by Professor Kölliker and his followers as cells, cells in the ordinary acceptation of the word?" That is to say, do they consist of a cell-wall and distinct contents, with a nucleus in the centre? or, are they, as Professor Ellis thinks, fibres made up of a number of threads or fibrillæ? As it happens that the smooth muscles occurring in the different organs of the body, although they bear a general resemblance to each other, yet differ as to structure in several particulars, it must be borne in mind that the following remarks are only applicable to the muscle described. In the intestine of the cat, kept a day or two in a weak solution of nitric acid, the "cells" very often present a corkscrew appearance throughout their whole extent, but more particularly at their ends. When pressed, they take on the wavy outline spoken of by Kölliker. Other "cells," more stretched, have a remarkable jointed appearance, like a bamboo cane, and when examined with a good lens of high power, the spaces between the joints are seen to have a linear arrangement, which Mr. Ellis thinks is produced by the fibrillæ. Be that as it may, one thing appears to me certain, that the spindle-shaped bodies, described by Kölliker as cells, *are solid*, for they may be cut across or torn longitudinally without any contents protruding or flowing out. The torn ends and sides

very often present a ragged appearance. If, on the other hand, these bodies are made up of minute fibrillæ, surrounded by a membrane, to which they are attached, the fibrils are so intimately connected with each other, that they cannot be separated except by tearing.

The integument of the frog, besides containing a great number of blood-vessels, is freely supplied with nerves. These have been very ably described by Czermak, and for the most part my observations confirm his. In one point, however, we differ; he says that many of the subdivisions of the nerves pass from the under to the upper surface of the skin through the perpendicular fibres, which, as was before mentioned, he regards as canals. The special purpose of these tubes or canals being to form a protecting sheath for the nerves, which, on reaching the upper part of the cutis vera, are reduced to merely the axis cylinder. As I regard these canals as a peculiar form of smooth muscular fibre, I cannot suppose that the nerves penetrate into, but only pass along the side of them.

There is yet a structure in the superficial layer of the cutis vera of the frog, which, as far as I am aware, has been described by no previous observer. It consists of a number of oval bodies, not at all unlike very small Pacinian corpuscles. These bodies are exceedingly numerous, and are distributed among the pigment-cells of the rete mucosum. I frequently attempted to trace the axis-cylinders of the nerves into these peculiar bodies, but without success. They are best seen when a weak solution of caustic potash is added to the skin, freed of its epidermis, in order to make it more transparent, and are roughly represented at Pl. VI, fig. 5, *b*.

The frog is not the only animal which has cavities in the skin, the mouths of which are covered over with a layer of tesselated epithelium. I found a similar kind of arrangement to exist in the skins of the newt and common water-lizard. In these animals, however, the cavities are of a somewhat different form, and less numerous than in the frog. The aperture in the middle of the tesselated epithelial covering of the lizard's skin is not of a triangular, but of an oblong shape; it sometimes measures as much as $\frac{1}{40}$ mm., and consequently may be said to have a still closer similarity to the ordinary form of vegetable stomates. The following description of the stomates of plants is given by Professor Lindley, in his 'Elements of Botany:' "Stomates are oval spaces lying between the sides of the cells, invariably opening into intercellular cavities in the subjacent tissue." This description of the stomates of plants cannot fail to strike the reader

as having a remarkable parallelism with that already given of the cavities in the skin of the frog. In the leaf the cavity is situated in the parenchyma (which is analogous to the cutis vera of animals), is covered over by the cuticle (which is equal to the animal epidermis), and has an opening in its centre. The shape of the aperture varies in different plants, but it is for the most part oval, as in the skin of the lizard. Some botanists adhere to the opinion that the stomates of plants are secreting organs, and not mere passages for the transmission of gaseous fluids; but by far the greater number are agreed in regarding them as respiratory organs. I am very much disposed to ascribe a similar function to the organs in the frog's skin, which resemble so closely the stomates in structure. They are exceedingly numerous, amounting to many thousands in a square inch of skin (I counted about sixty in the field of the microscope with a magnifying power of 70 diameters), and are found distributed over all parts of the body, being most numerous, however, on the back and on the dorsum of the limbs; exactly in those positions where the sudoriferous glands in other animals are most sparingly distributed. If a comparison be instituted between the cutaneous follicles of the frog and the true sweat-glands of other animals, a very marked difference will be found both as regards their position and their structure. Let us for a moment contrast the sudoriferous follicles of the human skin, as they are most generally known, with the organs which have just been described as existing in the integuments of the frog. In the palms of the hands and soles of the feet, as well as in the axillæ and groins of man, the greatest number of perspiratory glands are aggregated; and if the cutaneous follicles of the frog have a similar function to perform, we might not unnaturally expect to find them most numerous in the same positions. Such, however, is not found to be the case; for while, in the frog, the back and dorsum of the limbs and other exposed positions are thickly studded over with the mouths of the cutaneous follicles, the axillæ, palms of the hands, and soles of the feet, are almost entirely devoid of these organs. On the other hand, if we examine into the position occupied in the cutis vera by the tegumentary glands of the human subject and by those of the frog, we shall find, that while the former lie in the deepest, the latter are confined to the most superficial layer of the derma. The mode, too, in which the glands communicate with the exterior of the body, is in each case dissimilar; for while, in the skin of man, the channel of communication is a long, tortuous, and narrow duct, in that

of the frog it is a short, straight, and wide passage. In the human being there is no special covering to the mouth of the duct; in the frog, the passage is carefully closed over with a delicate layer of epithelium. Again, in the blood-vessels supplying the sweat-glands of man, we can detect nothing peculiar, while in those aggregated in the neighbourhood of the cutaneous follicles of the frog the usual function is found to be reversed; the arteries carrying forwards venous blood, the veins returning that which has undergone the arterializing process. It is thus seen that very little analogy can be traced between the sudoriferous glands of man and the cutaneous follicles of the frog, either as regards their structure or position. How different is the case when we attempt to compare the organs described in these pages with the respiratory apparatus of some of the lower animals. In the pulmonate gasteropods, for example, we have the lungs reduced to a simple sac, which, in many respects, resembles the little cavities in the frog's skin. In this simple form of lung, as well as in the stomates of the frog, we find the cavity lined by an involution of the epidermis, and its basement membrane surrounded by a network of fine capillaries. The contractility of both cavities presents us with still another point of resemblance. Dr. Ascherson has pointed out that the cutaneous follicles of the frog contract when a stimulus is applied to their nerves. He supposed that this property was dependent upon a layer of elastic fibres assisting to form the wall of the cavity, for at that time he was unacquainted with the true structure of the corium. I have not been able to detect any contractile fibres in the walls of the follicles, which appear to me to consist simply of a basement membrane and a layer of epithelium; but I have distinctly traced the widened-out ends of the perpendicular fibres already spoken of, ramifying on the exterior of the capsules.* The contraction of the cavities, I imagine, therefore, is produced by the shortening of the parallel and perpendicular bands of smooth muscular fibre composing the greater part of the true skin. I must now hasten to bring some evidence of the functional importance of the tegumentary respiration.

It was before mentioned that all animals respire more or less by their skin. In 1844, M. Fourcault † drew the attention of the French Academy to the interesting fact, that a

* Hensche also describes the smooth muscular fibres as composing part of the walls of the follicles; but, as has just been said, they do not, properly speaking, belong to the walls of the cavities, for they are only the spread-out terminations of the perpendicular fibres.

† Carpenter's 'Physiology,' p. 702.

complete suspension of the functions of the skin by means of a coating of varnish, gave rise to a state which he has described by the name of cutaneous asphyxia. In his experiments he observed that this condition was accompanied by an imperfect arterialization of the blood, upon which rapidly followed a marked decrease of the animal heat. This showed that the application of the varnish to the skin had not only prevented the insensible perspiration, but also the exhalation of carbonic acid and the absorption of oxygen. Had the perspiration alone been interrupted, the temperature of the animal's body would have increased, since it is to the evaporation of the sweat that the reduction of the animal heat is principally due. The constant evolution of heat from the cutaneous surface is replaced by the warmth developed during the combustion of the oxygen introduced through the skin and lungs, with the carbon and hydrogen of the tissues. The frog's skin is so perfect a respiratory organ, that in the absence of the lungs, it can carry on the diffusion of gases efficiently enough to support the life of the animal during several hours. Professor Moleschott has recently communicated to the French Academy some interesting experiments upon the effect of light upon the cutaneous respiration of the frog, showing that the function is much more rapidly performed in the sun's rays than during the absence of light. In the daytime more oxygen was absorbed, and more carbonic acid exhaled by the skins of the animals than during the night. From the peculiar organization and mode of life of this animal, as well as from the wide distribution and singular construction of the organs which it has been the purpose of this communication to describe, it appears not improbable that the follicles in the skin are more employed in the function of respiration than of perspiration; and I think we may therefore regard them rather as animal stomates than sudoriferous glands.

Description *of an* Object-compressor *for* Preparing *and* Mounting Objects. By W. Hislop, Esq.

(Read June 25th, 1856.)

This little instrument I have found extremely useful in the preparation and mounting of various substances as microscopic objects. It is so contrived as to afford a graduated pressure without the risk of breaking the glass cover. Any who have tried their hands at mounting objects permanently will at once see its applicability for all cases where a constant pressure has to be maintained for any time. For instance, if a section or other preparation is required to be mounted in balsam, it is necessary to keep the cover down until the balsam is cold, or the section will frequently curl, and lift it so as to admit the air; and this will sometimes occur even then. My plan is to have several of these compressors at hand, and as soon as the object is properly placed in the balsam, and the cover put on, the slide is at once placed beneath one of them, the trigger is let gently down, and the adjusting screw turned upwards, till all the superfluous balsam is expressed. The slide, still under the compressor, is then put aside in a drawer, until the balsam is hard enough to be safe. In like manner I apply it to the mounting of objects in fluid, being able to lay a coat of cement around the cover while it is under pressure. Previous to mounting, I also find it useful for flattening substances of all kinds, especially when being dried for mounting in balsam.

The figures show two forms of the compressor. Fig. 1

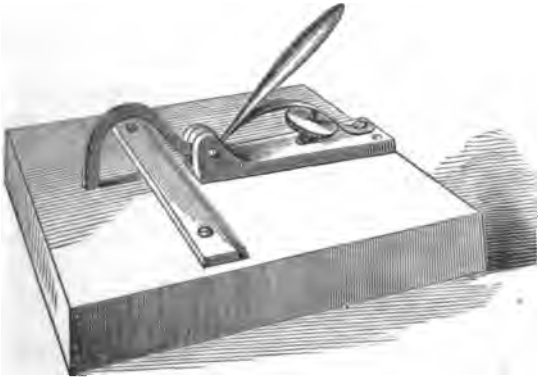


Fig. 1.

consists of a square block of mahogany, about three inches by four, across which a strip of brass is screwed, at a distance of one inch from one end, as a ledge, against which the glass slide is to be placed. A light trigger is jointed to the block in such a position that the end presses exactly in the centre of the slide. A steel or brass spring is fixed below the tail of the trigger, and beneath this a screw with a milled head is placed in such a manner as to increase the force of compression when it is unscrewed, by forcing the spring upwards, and *vice versâ.*

If preferred, a disc may be jointed to the trigger, so as to touch over an extended surface, or better still, a thin metal disc may be simply laid upon the cover, and the pressure be borne upon that. Care, however, must be taken that the balsam, or other cement, does not touch it, or inconvenience may result.

The second form, fig. 2, is identical in principle, but is made

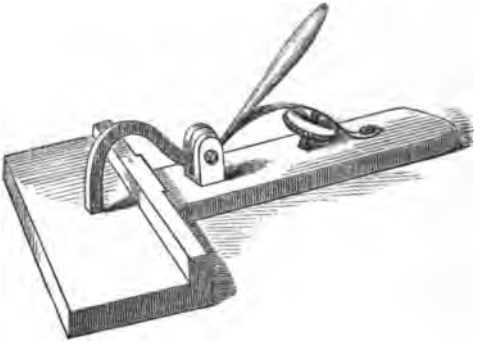


Fig. 2.

entirely of metal, and is useful when it is desired to apply heat at the same time as pressure, as it may be held over a lamp by grasping the prolonged end by the forceps, or it may even be fastened in a wooden handle.

On a Fungus parasitic *in the* Human Ear. By Jno. Grove, Esq., M.R.C.S., &c. Communicated by Henry Deane, Esq.

(Read April 15th, 1857.)

Having taken a lively interest for some years in the subject of parasitic growths of all kinds, whether occurring on animals or plants, I have lost no opportunity of seeking for them when occasions have presented offering any probability of success to my research.

In the month of September last (1856) I met with a beautiful specimen of a fungoid growth which was removed from the ear of a gentleman who had been suffering from inflammation of the left external meatus auditorius.

The ailment commenced with uneasiness and irritation of the ear, diminution of the sense of hearing, and some slight discharge. In a few days there was pain and greater urgency of the other symptoms. As the patient was in the prime of life, of unimpaired constitution, and apparently in vigorous health, I ordered simply poppy fomentations by means of spongio-piline, the ear to be carefully syringed with warm water, and a drop of glycerine to be applied night and morning—the syringing because there appeared to be some flocculent-looking matter deep in the meatus. After a day or two some of this flocculent matter came away in little masses, which was preserved according to order for my inspection.

The fungi to be presently described being detected, it occurred to me that the best method of preventing their further development would be to use some injection which was likely to be inimical to their existence. Alum was selected, and it seemed to answer perfectly. But soon the other ear began to take on the same symptoms as its fellow, and now the alum injection succeeded in checking altogether the progress of the affection, and the patient was speedily out of my hands.

The only instance of a growth of this kind in a like situation, that I am acquainted with, is in Robin's work; he quotes, however, from a paper by Mayer, in Müller's 'Archives.' He speaks of a fungoid vegetation which was found in some cysts removed from the ear of a child eight years old, who was suffering with a scrofulous discharge from the

external meatus, and had been treated both locally and generally with a variety of medicaments.

The differences between the description given by Robin and that which I have to offer are such as to lead to the belief that the objects are not similar.

1st. I detected no cysts, but flocculent membranous-looking masses.

2d. He describes the stipe as long, and containing within it small granules (or having a granular interior). Now although the accompanying has a rather long stipe, it does not contain spherules or granules.

3d. The pileus is said by Robin to be small and of a greenish colour, whereas that here shown is comparatively large and of a reddish-brown colour.

4th. The position and character of the spores are distinctly different. Robin speaks of them as granules, single or double, spread over the surface of the upper swollen extremity of the stipe; but those here exhibited are closely packed oval spores, completely enveloping the upper extremity of the stipe, forming a compact pileus.

Further, there is a difference in the cases furnishing the growth, the contrast between a scrofulous child, eight years of age, and a healthy man in the prime of life, is as great as could be, and tends to show that the scrofulous habit has no special influence in favouring the growth of the parasite. (Pl. VII, figs. 1—7.)

DESCRIPTION *of an* EARLY HUMAN EMBRYO *of about the fourth week of Utero-gestation.* By ARTHUR FARRE, M.D., F.R.S., Professor of Obstetric Medicine in King's College, London.

(Read May 13th, 1857.)

IN the year 1850 I had the honour of reading to this Society an account of a very early human embryo, the description and figures of which will be found in vol. iii, part ii, of the 'Microscopical Transactions.'

Having in that paper briefly explained the circumstances which render it a matter of great difficulty to obtain perfect specimens of the human embryo at very early periods of development, such as the violent pressure which the ovum suffers in the act of expulsion from the uterus, and the rough handling which it usually undergoes before it reaches our hands, independent of the rarity of procuring aborted specimens which are quite normal in their development, I need not here again advert to this subject. But I may observe, that while the development of the mammalian ovum has been traced through all its stages in many species (by the indefatigable Bischoff for example), the embryo of man has not been so carefully examined, especially in its early stages, as might fairly be expected from the great interest of the subject, even allowing for the impediments to the pursuit of human embryology to which I have just adverted.

It appears to me that the best way of supplying this deficiency is for each individual, who may have the opportunity, to record his observations, though they may be only of isolated examples; so that in time a number of such instances may be collated, and so a series may be obtained, which it is obvious, from the very nature of the subject, could not be formed in any other way.

I make no apology, therefore, for again drawing the attention of the members to this very interesting department of human physiology, by offering a brief description of another early human embryo which I have recently had the opportunity of examining.

This specimen was passed by abortion, for which no very obvious cause could be assigned, the mother being at the time in perfect health. From circumstances antecedent to the occurrence, I am not able to fix the age of the embryo

by reference to any of the ordinary modes of calculation. In this case two menstrual periods had passed by before the occurrence of abortion. But it is plain, from the condition of the embryo, that any calculation, having reference to this circumstance, would make its age far greater than the small amount of development which it has undergone would warrant. I have therefore no alternative but to estimate the period of development in this, as in the former instance, by comparing the embryo with others, the age of which could be more accurately ascertained. Judged by this test, I am inclined to fix the period of development of the present example at the early part of the fourth week of utero-gestation, and, as compared with the specimen which I formerly described, as probably three or four days younger than it.

The external characters of the ovum in this case were such as are commonly observed in the human ovum when expelled by abortion. It was loosely surrounded by the decidua vera and reflexa. The ovum having been freed from these, was found to be of nearly spherical form, the chorion being everywhere covered by dendritic villi, which were nearly equally distributed over its surface. The extremities of these villi were only slightly attached to the decidua, except in one situation where the two surfaces were united for a small extent. Taking the chorion as the boundary of the ovum proper, it measured one inch in diameter.

Upon carefully laying open the chorion with a pair of scissors under water, the embryo, the seat of which could be already discerned through the semi-opaque membrane, was at once brought into view. It was not enclosed in a separate amniotic sac, but the amnion appeared to be everywhere adherent to the inner surface of the chorion by the intervention of a loose connective tissue (magma reticule), so that the amnion, in this instance, was either not yet fully developed, or had not its usual distinct form.

The embryo itself, to which I will now confine my description, was attached to the parietes of this inner sac by a short peduncle springing from the posterior extremity of the trunk, just between the rudimentary buds which indicate the seat of the future lower limbs. This was, I presume, the root of the allantois, and in opening the semi-opaque sac through which I could see the situation of the head of the embryo, and in keeping as far as possible from this point, so as to avoid mutilating what I knew would be a very interesting part, I unfortunately cut across the pedicle of attachment, and so by trying to avoid Scylla I fell into Charybdis. I men-

tion this, because it will explain why I am unable in this paper to give any account of the allantois, which in an embryo of this date might be expected to present a condition of great interest; while, on the other hand, I am able to describe some points of fully equal interest, which are beautifully shown in the present example.

The embryo, in this case, presents the elongated and almost snake-like form which is commonly observed in the mammalian embryo of almost all classes at the periods of development which correspond with this. It is slightly curved, in the form of a bow, the head being inclined towards the posterior extremity of the trunk. In this curved condition it measures four lines, but its length would be increased by about one fourth if it were extended.

That which strikes the observer most at this period of development is the circumstance that here the embryo consists of those structures which are to be afterwards developed into parts and organs devoted to the purposes of what is termed the animal life, or those organs which bring the body into relation with the external world, such as the great centres of the nerves which relate to sensation and motion, the structures by which these are sustained and protected, the rudiments of the organs of locomotion, and some even of those relating to special sense, as the eye; while of those structures which are appropriated to the maintenance of the vegetative or organic life, scarcely a trace is as yet discoverable, beyond the heart or regulating organ of the circulation, which, at this period of development, constitutes the almost sole representative of that most important series of structures. At this period there is neither a thoracic nor abdominal cavity, for, with the exception of the heart, as first stated, the parts which these cavities contain and protect are not yet formed. The entire embryo therefore consists of a trunk, with the rudiments of a head and limbs, and of a heart for the maintenance of the circulation in the structures already formed, as well as in the membranes in which the embryo is inclosed, and which serve for the supply of its nutriment and for the aëration of its fluids.

It will be perceived by the drawing which accompanies this paper (Pl. VII, fig. 8 and 9), and in which I have preserved the proportion of all the parts, although the entire size of the embryo is magnified about seven diameters, that the head or anterior extremity of the trunk may be readily distinguished by the incipient development of those great nervous ganglia, or centres of nervous matter, which are connected in the first place with the principal organs of sense.

These great nervous centres appear at first in the form of vesicles, arranged in a linear series, whose unequal distension of the thin textures by which they are at this period covered in and protected causes the bulgings or tuberosities, so conspicuous in the part representing the head of the embryo. Three of these swellings may be readily distinguished. The most anterior of these (B) indicates the seat of the double vesicle which is afterwards developed into the cerebral hemispheres, at this time known as the prosencephalon. Its small relative size at this early period of embryo life is an interesting circumstance, when we consider how closely the cerebral hemispheres are connected with the intellectual faculties, and how greatly these portions of the brain preponderate in the fully developed organ. As, however, these faculties are not called into play at an early period of life, while, on the other hand, the organs of sense and relation must be exercised immediately upon the act of birth, we are not surprised to find the relative amounts of development of the nervous centres corresponding with these requirements. Behind the seat of the prosencepalon is observed another and rather larger bulging (C), which marks the situation of the mesencephalon or single vesicle of the corpora quadrigemina. Within the same bulging, but a little more anteriorly, is also found the vesicle of the third ventricle and the optic thalami. The mesencephalon, it will be noticed, is here larger than the prosencephalon, and, considering this as the great ganglion of the optic nerves, its great proportionate size is illustrative of the large relative proportion which this part of the brain exhibits in the lowest vertebrata. The third swelling (D) indicates the seat of origin of the acoustic nerve. It is the epencephalon, and contains the vesicle from which are developed the cerebellum and medulla oblongata.

Beyond this point a slight bending outwards indicates the situation of the commencement of the spinal cord, while the trunk is continued flexuous, but of nearly uniform size, until it terminates, after an abrupt curve forwards, in a pointed prominence indicating the seat of the future os coccygis.

Already it may be seen that the vertebræ are marked out, and, by the aid of transmitted light, their little quadrate divisions may be very distinctly discerned in the semi-translucent substance of which the trunk is at this period composed.

If now the eye is carried along the anterior surface of the embryo, there will be perceived, immediately below the anterior bulging indicative of the seat of the future cerebral hemispheres, a series of four laminæ or leaflets, which, when

viewed in profile, appear single, but which occur in pairs. These constitute no permanent parts or organs, but become transformed into various structures, such as the maxilla, mandible, &c. They are fœtal peculiarities of a most interesting class, forming here the visceral arches, or visceral-bogen of German physiologists, while the fissures or apertures between them are known as the branchial fissures or apertures. They are one stage less advanced in the present instance than they are in the embryo which I formerly described. Opposite to the lowermost pair of leaflets, a looped blood-vessel enters the trunk. This leads from the heart, at this period consisting of three chambers only, viz., a single auricle and ventricle, and a bulbus arteriosus. In my former paper having more particularly traced the development of the heart, and examined its composition, both at this stage of embryonic life and also at periods somewhat later, I refrain here from any further remarks upon this interesting portion of the subject.

Nearly on a level with the heart, though a little lower down, will be perceived a slender lamina projecting from the side of the trunk in the form of a small fin or paddle. This is the sole rudiment at this stage of an arm or anterior extremity. It constitutes the portion of blastema in which is subsequently laid down the chief portions of the structures forming the hand and arm, but which is not more developed at this stage of embryonic life than is the paddle of the whale or porpoise.

On the other hand, the rudiment of the lower limb or posterior extremity is more easily distinguished, in the form of a bud, projecting from either side of the trunk near its termination, but, like the anterior extremity, as yet in so rudimental a form that the last vertebræ of the spinal column still project beyond it.

Emerging from between these is the root of what I presume to have been the allantois, but which was unfortunately cut across in the manner already explained. By this channel the blood, after circulating through the body of the embryo, would be carried to the membranes by which it is encompassed, and at this point doubtless the connection between the parent and offspring, such as it is at this period, is established.

In front of the spinal column are distinguishable two or three structures, one of which only is sufficiently definite to admit of precise delineation. It is in the form of an elongated body, having apparently a duct running downwards towards the root of insertion of what I suppose to be the allantois. I have little doubt that this is a rudimental

Wolffian body, one of the earliest and most transient of embryonic structures.

As yet there is not only no indication of distinct sex, but the period of development is apparently anterior to that stage of embryonic life in which those organs are distinguishable, which, according to the views of Kobelt, may be subsequently converted into the essential parts of either sex indiscriminately. But upon this point I would not be understood as expressing a decided opinion, because the rudimental structures here distinguishable will require a more critical examination than I have been yet able to give to them.

[At the conclusion of this paper the author gave a brief exposition of his views regarding the signification and homologies of the principal structures here described.]

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ORIGINAL COMMUNICATIONS.

The Practical Use *of the* Microscope. By J. Hepworth.

(*Continued from* Vol. IV, p. 111.)

In making a post-mortem examination of a man about 63 years of age, who had laboured under gastric disease for two or three years and was extremely emaciated and dropsical, I found the stomach small, and containing about an ounce of yellowish mucus; there was no scirrhus, but the rugæ were thickened and more raised than natural, ecchymosis had occurred in different parts of the inner lining, but principally on the elevated ridges of the rugæ; the mucous lining over two or three of these spots had given way, leaving a small jagged ulcer. On examining one of these points I found that the vessels retained their form (although quite bare), except one or two, which had contracted and formed a knob about the $\frac{1}{400}$th of an inch in diameter at the point of rupture. There was a cicatrix, three quarters by five eighths of an inch in diameter, in which the muscular coat was wanting, but the mucous covering appeared to have been reproduced. On examining the mucus, it did not contain *Sarcina ventriculi* as I had anticipated, but some crystals of oxalate of lime (which I never met with in the stomach before), abundance of exudation corpuscles and what I conceive to be a vegetation (*vide* fig. 1). The corpuscles appear to have been the nidi of these formations, as I observed them in different stages of progress, as though each granule of the corpuscle supported a single cell, or plant; these becoming elongated, and so numerous as almost to hide the whole of the corpuscle from view.

The first appearance of any change in the corpuscle was the unusual development of the contained granules, as if they would start through the cell wall. They then assumed a light green colour, and appeared in the next stage either to have become further protruded, or had a cell added externally, which eventually became elongated into a semi-ellipsis of a very acute angle. The centre of the mass was of a brownish-olive colour; it had not a crystalline appearance, but each cell was more like the hair of a plant, being single.

On a superficial examination it appeared not unlike the crystals of lactic acid, but these cells were very different to

the long bundles of the crystals of that substance; the colour was also unlike, with both reflected and transmitted light.

On examining the lining membrane of the pelvis of the kidney, in the same subject, I detected a vegetation, which I shall, for want of a better, name *Sarcina renis* (*vide* Pl. I, fig. 2.)

About two years ago I met with a similar substance whilst examining some urine, but from its great similarity to one of the *Desmidieæ*, I concluded that it might possibly have got there by accident, and made no memorandum of it, except a sketch.

I find no notice of such a vegetation in Dr. L. Beale's excellent work on the microscope. In speaking of "matters of extraneous origin frequently met with in urine," he makes this very judicious remark, "With the microscopic characters of these bodies (giving a list at page 196) the student should be perfectly familiar as soon as possible, &c. Without this precaution he will find himself in constant difficulty, and his ignorance will cause him to make the most ludicrous mistakes."

There was no particular symptom indicative of the presence of these bodies, but in both the cases alluded to there was a general low state of vitality, as is always the case where vegetations are formed; for instance, in *Sarcina ventriculi*, aphthæ, &c. This reminds me of a sketch which I took some years ago of a specimen of aphthæ from a consumptive patient, which struck me as being peculiar (Pl. I, fig. 3). I am not aware whether it assumes this appearance in consumption invariably or not. The specimen (fig. 4) is a representation of the ordinary aphthæ in children.

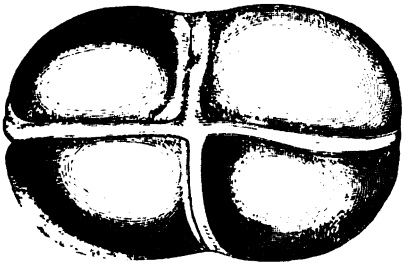
A boy, 13 years of age, with enlarged cervical glands, had complete obstruction of the bowels. There was hemorrhage, tympanitis, and occasional excruciating pain of the whole abdomen, stercoraceous vomiting, &c.

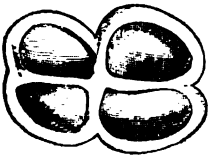
Post-mortem examination, fifteen hours after death.—The lumbar glands were enlarged, and had implicated the ileum immediately above the cæcum; small intestines very much increased, and large ones much diminished in capacity. In the immediate vicinity of the enlarged glands the intestines were not more than five eighths of an inch in diameter, and the obstruction was rendered still more complete by the protrusion of a mass of coagulable lymph inwards, arising from the condensed inner fibrous aponeurosis of the *muscular coat*, which was completely absorbed, leaving only cellular tissue containing a few vessels. There was general peritoneal inflammation and

all its consequences, effusion of serum, patches of lymph, &c. The peritoneum at the contracted part was very much thickened, brown, and scirrhous; the inner and outer fibrous aponeuroses of the muscular coat were also very thick, white, and dense, with transverse striæ (fig. 5), and appeared to have been pushed inwards considerably beyond the level of the mucous coat, which had been reflected on each side of the protruding mass. The accompanying sketch gives a general outline of a longitudinal section of the contracted part. The cellular tissue, which was left in place of the muscular coat, appeared to pass through the inner aponeurosis at intervals, probably opposite the valvulæ conniventes.

The following is a note of the case above mentioned:

J. S—, about 26 years of age, had difficult micturition, with anasarca of the extremities. The symptoms led me to examine the urine from time to time, in which I found what I called, it appears, at the time, *Sarcina vesicæ*. The urine did not coagulate on the addition of nitric acid. He gradually recovered as the general tone of the system improved. If this be the same vegetation as the other, it must be in a state of germination; it was about the same colour as the one sent. I took no measurement of it, therefore cannot say what size it is. You can make what use of it you please; perhaps a memorandum of it in a woodcut may cause others to be on the look out for similar specimens.





NOTES *of a* MICROSCOPICAL EXAMINATION *of* "MEASLED" *and other* PORK. By WILLIAM SMITH, F.L.S., Professor of Natural History, Queen's College, Cork.

THE subject of the present paper has of late excited much attention in this locality, the trade of the port of Cork and the industry of the neighbouring counties being immediately connected with the produce and export of provisions, a main portion of which consists of cured pork.

The disease in pigs popularly known as "measles" (though without any resemblance to the complaint bearing the name in the human subject) is one of frequent occurrence in the South of Ireland, and as its presence in the flesh of the animal is usually regarded as detrimental to its value as an article of food, the market-price of the commodity is thereby lowered, and the profits of the producer proportionally diminished.

Questions connected with the supply of provisions to the Crimean army having called increased attention to this subject, an attempt was lately made by the provision-merchants of Cork to arrive at more certain conclusions respecting the nature and extent of the disease, and its precise influence on the character and condition of the flesh affected by it.

Having been invited to assist in this research, by reporting on the microscopical appearance of the disease, and the meat affected by it, the following notes of a careful examination of fresh and cured pork, supplied to me, were my contributions to the inquiry:

The facts noted are not new to science, the subject having attracted the attention of several German, French, and British physiologists, and the results of their investigations being for the most part similar to my own.

The matter has not, however, been discussed in the 'Micr. Journ.,' and the following record of independent observation, and personal inquiry, may interest the readers of this magazine, and possess corroborative value when taken in connection with the more important investigations of other naturalists.

Nineteen specimens were supplied to me, viz.:

6 of healthy fresh pork from various parts of different pigs;
6 of fresh muscle, "slightly measled;"
6 of fresh muscle, "badly measled;"
1 of cured pork, "badly measled."

The "measles" are occasioned by the presence of a para-

sitic worm, known to physiologists and anatomists as the "*Cysticercus cellulosæ.*"

This worm, as it occurred in the muscle or flesh of the pork supplied to me, consists of an external bag or cyst of delicate rugose membrane, enclosing the animal of the *Cysticercus*, retracted within its folds; the space not occupied by the worm being filled with a clear watery fluid.

Pl. II, fig. 1, represents the natural size of the "measles" in fresh muscle; fig. 2 the same in stale or salted pork; and fig. 3 the same from fresh muscle, magnified 6 diameters.

The animal of the *Cysticercus*, when withdrawn from the cyst, within which it lies invaginated, and curled up, in all the specimens, consisted of a slightly enlarged head, fig. 4 *a*, and a neck formed of numerous rings, fig. 4 *b*, gradually enlarged into a bladder-like vesicle, fig. 4 *c*, which constitutes the body of the worm.

The neck and body of the *Cysticercus* are filled with a mass of minute transparent bodies, which a further examination leads me to regard as cellules discharging the function of assimilation, *i. e.*, converting the material endosmotically absorbed by the cyst and bladder-like vesicle into the substance of the *Cysticercus*. The form of these cellules is usually that of a flattened circular disc, and their average diameter $\frac{1}{1500}$th of an inch, but neither their size nor form is constant, some being linear, others irregular in outline, and many not exceeding $\frac{1}{3000}$th of an inch in diameter.*

The head of the *Cysticercus* is provided, at its extremity, with a circlet of about 24 hooklets (fig. 5 *a*), immediately beneath which are situated 4 circular organs, *b*, *b*, afterwards more fully developed in the mature condition of the *Cysticercus*.

The hooklets, upon further examination with higher powers of the microscope, are seen to consist of a stem fixed in the flesh of the head (fig. 6 *a*), a barb (fig. 6 *b*), and a sickle-like point (fig. 6 *c*).

The *Cysticercus*, as above described, constituting the "measles," is imbedded *between* the fasciculi of the muscle, and occupies a chamber formed by the inflation of its cyst.

The cyst which in a fresh state fills the entire chamber, on the death of the pig parts with its contained fluid, which permeates the surrounding tissues.

The chambers then collapse, and the muscle in consequence becomes soft, and flabby to the touch.

* [These elliptical bodies are composed in most part of carbonate of lime, and would appear to be intended more for the purpose of giving greater firmness or solidity to the part of the entozoon in which they occur than for any other function.—Eds.]

The "measles" in the specimens supplied to me were all visible to the naked eye, the cysts when inflated being of an elliptical form, and having an average length of about one third of an inch.

The coil of the enclosed worm was nearly globular, with an average diameter of about one tenth of an inch.

In the "slightly measled" pork the size of the worm was often less than in the "badly measled," but in every case the *Cysticercus* seemed to have reached the same degree of organic growth, and in none of the specimens, "healthy" or otherwise, could I detect the slightest trace of the animal in an earlier stage of development. Had the eggs, or young animals, existed, they could not have escaped my notice. In the specimens marked "healthy" there was no trace whatever of the *Cysticercus*.

The muscular tissues at a little distance from the cysts did not present any distinct alteration in their normal and healthy character, but in the immediate neighbourhood of the cysts there were evident traces of the altered or diseased condition of muscle known to physiologists under the name of "*fatty degeneration.*" Where the "measles" are numerous *fatty degeneration* would be proportionally great in comparison with the amount of healthy muscle.

In the salted specimen the cysts were empty of fluid, and the "assimilating cellules" in the body of the worm had become somewhat opaque, presenting a central granular nucleus instead of the clear transparent appearance noticed in the fresh specimens. I conclude from this that the life of the *Cysticercus* is destroyed by the process of "*curing.*" Fig. 7 shows the appearance of the assimilating cellules in the *fresh*, and fig. 8 in the cured specimens.

It is maintained by the most eminent physiologists of the present day, that the *Cysticercus* of the pig is the "scolex," that is, the intermediate or arrested condition of the "*Tænia solium,*" or tape-worm of man and other mammalia.

The organization of the *Cysticercus*, as above described, goes far to establish this opinion, and direct experiments instituted upon dogs and other quadrupeds fed upon fresh "measled" pork seems to place it beyond a doubt.

In the present case there was neither time nor opportunity to verify this theory by direct experiment.

The history of the early condition and future development of the *Cysticercus*, the pathological and hygienic deductions to be drawn from the above observations, and their bearing upon the wholesomeness or otherwise of fresh, cured, or cooked "measled" pork are questions which appertained to

the branch of the inquiry entrusted to my colleagues; I may, however, observe, that the microscopical examination here detailed would lead to the conclusion that the presence of the *Cysticercus* in the small numbers which occur in "slightly measled" pork does not appreciably affect the healthy condition of the muscular fibre, and that it is only when the numbers of this parasite are considerable that the fatty degeneration and watery condition of the muscles become apparent; and as it further appears that the operations of curing, or cooking, destroy the assimilating powers of the cellules, and consequently the life of the *Cysticercus*, it would seem that no apprehension need be entertained of tape-worm following the use of "measled" pork, provided the flesh be carefully cured or thoroughly cooked.

Description *of some* New Diatomaceous Forms *from the* West Indies. By Robert Kaye Greville, LL.D., F.R.S.E., &c.

Some months ago I received a box of shells from my friend Mrs. William Eccles, of Trinidad, among which was a small marine species covered with an entangled tuft of sea-weeds and zoophytes. This, as it appeared to contain *Diatomaceæ*, I manipulated in the usual way, and on careful examination found it to yield a number of exceedingly interesting kinds, especially if the very small quantity of the prepared material be considered. As it would scarcely serve any useful purpose to work out every form which presented itself in a gathering so trifling in extent, I propose to confine myself on the present occasion to the description of such as seem to be new; and I shall only mention that among the remaining forms worthy of notice the following were observed: *Synedra undulata*, Bail., *S. superba*, Kütz., *Cocconeis Grevillii*, Sm., *Navicula Hennedyi*, Sm., *N. crabro*, Eh.,* *Amphora obtusa* and

* As Professor Smith has not yet given a figure of this species, I can only conclude from his description, which most accurately agrees with the form before me, that I am correct in my reference. The figures engraved by Ehrenberg, in his 'Microgeologie,' Pl. XIX, fig. 29, are not satisfactory, especially *a* and *b*. The half frustule *c*, however, is probably the true form, with the faint moniliform structure of the striæ omitted, and the constriction far too widely concave. In the absence of authentic materials, I cannot venture to speak with any certainty of *Navicula pandura* of De Brébisson,

A. lineata, Greg., *Podocystis Americana*, Bail., *Climacosphenia moniligera*, Eh., *Rhabdonema arcuatum* and *R. Adriaticum*, Kütz., *Grammatophora hamulifera*, Kütz., *Asterolampra impar*, Shadb.

1. *Cocconeis punctatissima*, Grev. Valve elliptical-oval, densely areolato-punctate; striæ moniliform, concentric with the extremities, the moniliform structure ceasing within the margin so as to leave a simply striated border; median line dilated towards the extremities. Length of frustule 0·0020″ to 0·0024″; breadth 0·0012″ to 0·0015″. Striæ 20 in 0·001″. (Pl. III, fig. 1.)

Hab.—All the species in this paper are marine, from the Island of Trinidad.

One of the most beautiful species I am acquainted with, and closely allied to a new MS. species from the Black Sea, distributed by Professor Smith under the name of *Cocconeis Morrisii*; in fact, a mere cursory examination might readily leave an impression on the mind that the two were nothing more than varieties. A careful comparison, however, has satisfied me that they are truly distinct. The general outline is the same in both, but the striæ in *C. Morrisii* are coarser and far less numerous than in the West Indian Diatom. The beading is also much larger, more equal in size, and more separated. In *C. punctatissima* the beading, in consequence of the very numerous striæ, becomes more minute as it joins the median line, which latter presents the appearance of a rather broadly linear, indistinctly defined, pale space, dilated towards the extremities, where it terminates elliptically. In the single valves, which are most frequently met with, there is but one side, as it were, of the median line visible, which gives them a very peculiar aspect.

It is more difficult to separate this species by a written character from the variable *C. placentula*, although the

who defines the striæ as simply costate. Under these circumstances, I take the opportunity of offering an illustration of *N. crabro*, as it occurs in my Trinidad gathering, in the hope that it may be regarded as a faithful typical representation. The truth is, the group to which this species of *Navicula* belongs is one of great perplexity, and I trust that my friend, Professor Gregory, who is studying it, will do something towards clearing it up. The two forms which he has named *N. nitida*, Sm.? in the fourth volume of the 'Transactions of the Microscopical Society,' will probably prove to be the same as our present species, the moniliform structure having been perhaps overlooked from its extreme obscurity. As the name above mentioned does not occur in the second volume of Professor Smith's 'Synopsis,' that of *N. crabro* has doubtless been substituted for it. The outline and general character of Professor Gregory's *N.? pandura*, Bréb.? is also extremely similar to the Trinidad Diatom.

features are immediately appreciated by the eye. *C. punctatissima* is more uniform, and considerably larger; but the best mark is the conspicuous peculiarity of the median line, which in *C. placentula* is simple.

2. *Cocconeis crebrestriata*, Grev. Valve elliptical, delicately, closely, and uniformly punctato-striate; striæ concentric with the extremities; median line straight, simple. Length of frustule 0·0022″ to 0·0028″; breadth 0·0012″ to 0·0014″. Striæ 30 in 0·001″. (Pl. III, fig. 2.)

A well-characterised species. The striæ are numerous and closely arranged, with a faint appearance, requiring careful adjustment in order to render them distinct. Under higher powers the sculpture of the striæ exactly resembles ordinary cellular tissue, which under inferior powers causes the uniform oval-punctate appearance. Occasionally a border of the valve is indicated by a faint line, as seen in the figure, but this is not always apparent.

3. *Cocconeis inconspicua*, Grev. Valve nearly circular, border broad, rather strongly striated; disc diaphanous; striæ concentric with the extremities, faint, obscure in the centre. Diameter of frustule 0·0011″. Striæ at margin 22 in 0·001″. (Pl. III, fig. 3.)

This is a most delicate form, so transparent as to be very easily overlooked. The border being the most strongly marked, first catches the eye, appearing like a mere striated ring, until the median line and nodule be brought into focus. The striæ of the disc are perceptible for about a third of the space between the border and the median line, when they gradually become quite obscure.

4. *Campylodiscus fenestratus*, Grev. Valve nearly circular, the broad prominent border composed of a series of narrow cells; disc with four lattice-like sculptures formed by 3—4 bars crossing each other at right angles. Diameter of frustule 0·0023″. (Pl. III, fig. 4.)

No drawing can do justice to the exceeding beauty of this Diatom. The broad and prominent border is equal to about a fifth part of the whole diameter, and is composed of narrow parallel cells, which, at first sight, have the appearance of a double series, a deception arising from an undulation in the substance of the valve. Radiating striæ appear to pass from the border for a short distance towards the centre of the disc, which is occupied by four remarkable sculptures, exactly resembling square windows in miniature, the bars sharp and slender, and the panes actually appearing as if they transmitted light. The windows are not perfectly symmetrical, as some of the rows of panes are larger than others; never-

theless the resemblance is so perfect, that, if it were possible, they might pass for the reflection of real windows. The figure cannot give the effect of this, as the transparency of the valve is necessary to complete the deception.

5. *Campylodiscus Ecclesianus*, Grev. Valve nearly circular, the border composed of a double series of narrow-oblong cells; disc with two rows of short, broad, truncated bars, separated by a broad median line, from each end of which radiate a semicircle of fine striæ. Diameter of frustule 0·0024″. (Pl. III, fig. 5.)

Of this fine species, not less charming in the elegance of its sculpture than the preceding, the gathering furnished two examples. It is similar in size to the last, but somewhat more contorted, so that, when one portion of the valve is in focus, the details of the remaining portion are less visible than as they are represented in the figure. The valve is very concave. The central part of the disc occupied by the two rows of bars is nearly flat; but on each side of the rows and at their termination the disc is inflated; the lateral inflations being unsculptured, the terminal ones ornamented with striæ, which radiate from the ends of the median line, and stop before reaching the border, so as to form a semicircle. I am not aware of any known species which can be brought into comparison with this splendid form, on which I have conferred the name of Mrs. William Eccles, a lady who has most kindly collected for her friends many objects of natural history in the Island of Trinidad.

6. *Surirella eximia*, Grev. Valve linear-oblong, rounded at the ends, very slightly constricted in the centre; canaliculi delicate, about 18 on each side, reaching the narrow-linear, transversely striated median line, which is attenuated towards the ends, and becomes as narrow as the canaliculi. Length of frustule 0·0020″ to 0·0028″; breadth 0·0008″ to 0·0012″. (Pl. III, fig. 6.)

This extremely delicate and hyaline Diatom approaches *S. lata* in form, but differs in every other respect. The canaliculi are equidistant, and as fine as those of *S. gemma*; the alæ narrow, but conspicuous. A characteristic feature is the linear, transversely striated median line, which is gradually attenuated at each extremity, until at about the third or fourth pair of canaliculi from the end it becomes as slender as the canaliculi themselves.

7. *Navicula Gregoriana*, Grev. Valve elliptical-oblong, with abruptly produced and rounded ends; striæ obscurely moniliform, interrupted on each side by a longitudinal, linear, blank space, which slightly converges towards the central

nodule. Length of frustule 0·0024″ to 0·0038″; breadth 0·0010″ to 0·0014″. Striæ 25 in 0·001″. (Pl. III, fig. 7.)

A very striking and interesting species, of which I have seen two individuals of the sizes indicated in the specific character. Like others of the group to which it belongs, it would appear to vary greatly in its dimensions. It seems to be most nearly related to *N. clavata* of Gregory ('Trans. Micr. Soc.,' vol. iv. p. 46, Pl. V, fig. 17), which it closely resembles in general outline; but, as Professor Gregory has already remarked, there can be no doubt regarding the distinctness of the present form. The most conspicuous difference lies in the blank space which interrupts the striation on each side throughout the whole length of the valve. In *N. clavata* this space follows nearly the same rule as in *N. Hennedyi*, Sm., the outer boundary of the space corresponding with the curve of the valve. Whereas, in the Diatom under consideration, the blank space constitutes a mere linear band, running parallel with the median line, except at the centre, where it bends slightly towards the nodule. Between this space and the median line the interrupted striæ form also linear bands, which are continued into the produced extremities. The striæ are more numerous than in *N. clavata*, and very obscurely moniliform. Another species to which our new Diatom bears, at first sight, no inconsiderable resemblance, is *Pinnularia* (*Navicula*) *Couperi* of Professor Bailey, described in his microscopical observations made in South Carolina, Georgia, and Florida. ('Smithsonian Contributions to Knowledge,' vol. ii.) In that form, however, the ends are not suddenly produced, the sides are somewhat constricted, the striation is conspicuously moniliform, and the blank spaces, instead of running parallel with the median line, and terminating at the angle where the produced ends spring from the lateral curve of the valve, are gradually attenuated, and converge and terminate with the median line itself at the nodule. I have much pleasure in dedicating this fine species to my friend Professor Gregory, whose acuteness and perseverance have converted the unpromising sand of Glenshira into "diggings" rich in new and curious forms.

8. *Navicula compacta*, Grev. Valve broadly oblong, constricted at the sides, the shoulders much rounded, ends suddenly produced, obtuse; striæ becoming faint towards the middle, where they are stopped by a line running close to and parallel with the median line. Length of frustule 0·0010″; breadth 0·0006″. Striæ about 42 in 0·001″. (Pl. III, fig. 8.)

I am not aware of any described species which approaches the present minute form. The striæ are slightly radiate, and though quite evident at the margin, become gradually faint. The line which runs on each side, parallel with the median line, passes through the valve, as it were, to form the produced extremities.

9. *Pleurosigma compactum*, Grev. Valve linear-lanceolate. obtuse; flexure of the median line so great that it touches the margin, about midway between the central and terminal nodules, the curve following the same gradient to the extremity; striæ obscure. Length of frustule 0·0035″ to 0·0045″; breadth 0·0006″ to 0·0008″. (Pl. III, fig. 9.)

This *Pleurosigma*, of which I possess several specimens, is well marked by the excessive flexure of the median line, which is greater than in any species known to me, while the flexure of the valve itself as it is presented to the eye is so moderate, that a straight line drawn from the terminal nodules through the central one, passes considerably within the margin. From the point where the curve of the median line touches the margin, the latter, to the *furthest* extremity, is nearly straight, and is just perceived exterior to the curve of the median line, as the latter approaches the *nearest* end.

10. *Mastogloia minuta*, Grev. Valve elliptical-oval to elliptical-oblong, conspicuously apiculate; loculi 12 to 18; striæ very fine and close. Length of frustule 0·0008″ to 0·0010″; breadth 0·0004″. (Pl. III, fig. 10.)

Although I have seen numerous frustules of this minute Diatom, I have been unable to obtain a front view. As a species it is evidently allied to *M. apiculata* of Smith; but it differs in being scarcely half the size, and essentially in the much larger loculi. It is also much more decidedly apiculate, being generally even strikingly rostrate.

TRANSLATIONS.

ALGARUM UNICELLULARIUM GENERA *nova et minus cognita, præmissis* OBSERVATIONIBUS *de* ALGIS UNICELLULARIBUS *in genere.*

New and less known Genera of UNICELLULAR ALGÆ, *preceded by* OBSERVATIONS *respecting* UNICELLULAR ALGÆ *in general.* By ALEX. BRAUN. (Leipsic, 1855; with six Plates.)

THE author, after adverting to the important aid to be derived from the study of the lowest plants, and especially of the *Algæ*, and more particularly of their evolution, in the advance of our knowledge of the morphology and physiology of plants, and the establishment of a systematic arrangement of the vegetable kingdom, proceeds to some observations concerning unicellular *Algæ* in general, the substance of which is as follows:

Whether or not unicellular plants really exist, appears to be a question of no light moment towards the understanding of the gradation of Nature in ascending from the lower to the higher organisms, and especially towards the construction of a methodical arrangement of the vegetable kingdom in congruity with Nature, whose principles, as well as the correct appreciation of the nature of each plant, are chiefly to be sought in the study of the processes of evolution.

For our knowledge of the natural system of plants, which is daily increasing, indicates, in scarcely dubious terms, a parallelism between the primary divisions of the vegetable kingdom and the principal stages of morphosis presented in the development of each individual plant (that is to say, of those belonging to the more perfect class); and thus is shown a certain analogy between the vegetable kingdom and the organism of the individual plant, and the prevalence of a similar law of evolution proceeding by steps, in each.

It is well known that the primary germ and rudiment of the nascent plant is a homogeneous and indifferent substance, presenting scarcely any differences either in external form or internal constitution. In phanerogamous plants this is apparent in the formation of the embryo sac,* which is ultimately changed into the substance of the endosperm, and to

* That the embryo sac is the commencement of the future plant, besides by analogy, is proved by its nature, inasmuch as being disconnected from the parent tissues, and destroying by its own growth the texture of the surrounding cells, it leads as it were a parasitic life within the parent plant.

which, among the vascular cryptogams, the pro-embryo or *prothallium* corresponds. After fecundation, there arises from these transitory primordia another and principal series of vegetable generations, commencing from the embryo, and producing the vegetative *stirps*, by whose evolution in opposite directions the differences of *root*, *stem*, and *leaves* are produced. Subsequently, in the ascending portion of the *stirps* the morphosis of the plant is continued, and those stages of the process appertaining to the vegetative life having been established, it passes into a new stage by the formation of the *flower*, and by the intervention of the flower ultimately attains to the object of the whole vegetation in the production of the *fruit*.

A similar kind of gradation is exhibited in the vegetable kingdom taken as a whole. This begins, as is obvious, in the more simple plants, which present only trifling distinction of organs either external or internal, the root, stem, and leaves being either, as it were, fused together or ambiguous. They have neither flower nor any true fruit; the organs of fructification are closely connected with those of vegetation, and the act of fecundation, if any take place, is competent merely to excite, as it were, the first stage of evolution of the plant, since there is no succeeding generation whatever.

To this category belong the lower cryptogamous plants, aphyllous or simply cellular, and which have been, not inappropriately, termed by recent writers—*protophytes* or *thallophytes*. They represent, as it were, the pro-embryos of the higher plants, and constitute, in fact, the primordial vegetation in protogæan history, as well as in the existing economy of nature, forming the broad foundation of the whole vegetable kingdom.

This primary division in the natural system is succeeded by another, characterised by a heteromorphous, duplex vegetation, for a knowledge of which we are especially indebted to the discoveries of recent observers; for to the primary and transitional vegetation, that is to say, to a homogeneous prothallium, aphyllous and merely cellular, fecundation being completed in the prothallium itself, succeeds another, characterised by the distinct formation of external parts (stem, root, and leaves), as well as by the constitution of the internal texture composed of a mixture of cells and vessels. Thus from a lower stage the vegetation is advanced by successive generation to a higher, but without its ever attaining to the ultimate goal, inasmuch as plants belonging to this division, in which the progress of the metamorphosis is interrupted, and remains at the stage of a vegetative stirps, never arrive at the production of flower and fruit distinct from the vege-

tative formations. To this category belong the higher, vascular cryptogams, furnished with leaves, of which, according to authors, and also from the historical evidence supplied by geology, is constituted the second division of the vegetable kingdom, formerly the highest throughout the more ancient periods of the protogæan Flora. The term *cormophytes* might be employed to distinguish the plants included in this section.

The plants belonging to each of the above divisions, and which have conjointly, since the time of Linnæus, been termed *Cryptogamia*, all agree in the circumstance of their wanting flowers and true fruit, a character by which they were distinguished by those fathers in Botany who are esteemed by Linnæus as the first orthodox systematists—Cæsalpinus and Ray. These are succeeded by the floriferous or phænerogamous plants (*anthophytes*), which again, like the cryptogams, exhibit a binary division, according to the degree of evolution which they reach; for there are some in which the production of the flower commences, indeed, through a more exalted metamorphosis of the leaves, but is not fully completed, the carpellary leaves which constitute the true fruit enclosing seeds being deficient. As plants of this kind, which, though furnished with a flower, have no true fruit, are to be regarded the *Cycadeæ* and *Coniferæ*, which, formerly the subjects of futile and vain attempts at explanation, are now admitted without doubt to be gymnospermous, a truth for which we are indebted to the sagacity of Robert Brown. That the gymnospermous anthophytes really constitute a separate and independent group, by no means to be associated with the dicotyledons, with which they have hitherto been classed by most systematists, is proved by their habit,* the very incomplete structure of the flowers, the disposition and unusual form† of the stamens, and by the structure of the wood, but chiefly by the mode of generation, whose very manifest analogy with that of cryptogams has been excellently illustrated by Hofmeister. It is manifest, therefore, that they must be put in the lowest place, among the phanerogams, conterminous with the cryptogams, an arrangement which is favoured

* The habit of the *Cycadeæ* is manifestly filicoid, and that of the *Coniferæ* to a certain extent like that of the *Lycopodiaceæ*. The foliation of *Salisburia* can only be compared with the fronds of *Marsilia* and of some ferns (*Schizeæ*, *Adiantum*).

† Their disposition always in continuous spirals, never in determinate cycles (verticells); form more or less foliaceous and expanded; anthersiferous thecæ frequently numerous, whence a certain degree of resemblance to the sporanziophorous traits of *Lycopodium*, the sporophylls of *Equisetum*, &c.

not less by geological than it is by morphological considerations.

Another division, lastly, of phanerogams, in which the highest stage of the vegetable kingdom is reached, embraces all flowering plants which at the same time produce true fruit—angiospermous anthophytes; and in this section the subdivision into monocotyledons and dicotyledons is of secondary importance.

In what way the vegetable kingdom, as far as concerns the scale or gradation of evolution, agrees in general with an individual plant, may, with respect to the first commencement of the lowest step, be so specifically compared, that a law of analogy is clearly apparent in the accordance of the lowest plants with the lowest state of a higher plant. It is evident that every plant commences in a solitary and simple cell, either a spore or an embryo sac; it is clear also that the succeeding (succedaneous) generation originates in a simple cell (embryonic vesicle); the vegetable kingdom presents an analogous commencement; its lowest members are plants unicellular throughout their life—plants, that is to say, constituted of a single cell persistent through the whole period of evolution, and performing all the vital functions. The existence of unicellular plants of this kind has been long and frequently shown, though demonstrated by imperfectly known, and for the most part erroneous examples, until Nägeli laid a new foundation for the doctrine, in his careful illustrations of several genera of unicellular *Algæ*, and their classification according to a new method. But the limits within which that experienced observer circumscribed the unicellular *Algæ*, appear to the author too restricted, and scarcely such as should be closely observed; a circumstance which some have endeavoured to turn to the disparagement of the doctrine itself, going so far as wholly to deny the existence of unicellular *Algæ* at all, or even as to declare that the proposed genera were most of them the *primordia* merely of more perfect *Algæ* or of other plants, whilst others were said to be the ova of animalcules. It is scarcely worth while to attempt the refutation of these opinions, since they are unsupported by arguments derived from accurate observation, and because all who may enter with unprejudiced views into the vast domain of the lowest *Algæ* will be convinced that the truth is otherwise.

(*To be continued.*)

NOTES AND CORRESPONDENCE.

Note on Vorticella.—One evening watching an *Actinophrys Sol* procuring his supper, *more suo*, my attention was attracted to an object in another part of the field also feeding, but in a manner never before observed by me.

This was a common *Vorticella* (*Nebulifera*) feasting on a large jelly-like mass which much resembled the body of an *Amæba*. Instead of the ordinary, apparently rotatory, vortex-creating movements of the ciliæ, whereby food is usually brought to the œsophagus, ciliæ were seen protruded from within the oral aperture and applied, *as we would our finger and thumb*, in picking out from the gelatinous mass the oily-looking particles with which it was studded. After appropriating several of these, the creature would suddenly retreat, by the contraction of its pedicle, beneath a leaf of duckweed, from which, in a few seconds, it would emerge, again to renew its feast.

I continued to watch this proceeding until I had seen it repeated a great number of times; and I distinctly noticed that, as the highly refracting particles disappeared from the gelatinous mass, the body of the *Vorticella* appeared to become more and more charged with them.

Dr. Carpenter, in his recent work on the microscope, observes—"There is no reason whatever to believe that these animalcules (*Vorticellæ*) possess any organs of special sense." And again, "If they are really endowed with consciousness, as their movements *seem* to indicate, though other considerations render it very doubtful, they must derive their perceptions of external things from the impressions made upon their general surface, but more particularly upon their filamentous appendages."

I would merely remark that it is difficult for an ordinary understanding to dissociate the phenomenon here recorded, of this humble *Vorticella* selecting its food from corresponding actions in beings possessed of undoubted "consciousness"—difficult not to regard this diminutive creature, selecting its dainty morsels, even as a type of our own humanity.—H. Wilson, Runcorn.

Comatula rosacea—Encrinitic State.—In his recently published work on 'The Microscope and its Revelations,' Dr. Carpenter has announced the discovery of the young or encrinitic state of the *Comatula* in Lamlash Bay, where, he says, "it is so abundant that it may hereafter find its way into almost every cabinet." I have found it in the same locality, when dredging along the shores of Holy Island. Lamlash Bay, indeed, is rich in *Echinodermata,* yielding many of the finer species, and amongst them the beautiful *Echinus Flemingii.*

It may be interesting to some of the readers of the 'Journal' to know of a *southern* habitat for so great a rarity as the young *Comatula.* I have obtained it in abundance in Salcombe Bay on the Devonshire coast, between the end of July and the middle of September. It occurs profusely on sea-weeds, zoophytes, stones, &c. I have in my possession a bunch of weed from this locality which is literally covered with young *Comatulæ,* in every stage of development. Salcombe is on the South Devon coast, and about five miles from the town of Kingsbridge.—THOMAS HINCKS, Leeds.

Glaucoma scintillans.—The germs of this Infusorium exist in the atmosphere.

After boiling an infusion of chlorophyll (dried juice of cabbage and distilled water), in which I had been breeding *Glaucomæ,* but from which all traces of life had disappeared, I exposed the boiled solution to the atmosphere, and in less than a week tolerably large *Glaucomæ* were again visible.

Form.—*Glaucoma* changes its shape from that of an elongated oval in the earlier stage of its growth to various other forms.

I have not been able to discern an external integument; the internal substance of the body, which appears semi-fluid, solidifies towards the outer part as the animalcule increases in size. Possibly the cells may be developed in the centre, which always remains more liquid than the remaining portion of the body.

Internal structure.—Besides the vessels to be described, there are many small granules which, on minute examination, have the appearance of cells.

Glaucoma has no bowel.—What Professor Ehrenberg mistook for a winding canal is simply the vacant space between the internal globules, which sometimes presents that appearance when they are very numerous; at first sight it is very likely to deceive the observer.

The mouth is a slit or tear in the outer surface, it forms the wide entrance to a conical *gullet*.

I have crushed a great number of *Glaucomæ* with the covering glass, and on examining them immediately afterwards, some which were still alive had been torn open at the opposite side of the body, and food was entering there just as at the mouth.

The particles of food enter the gullet and accumulate at the pointed extremity. Whether they there are admitted into a cell ready constructed, or simply form themselves into a ball, I have not yet been able to see. But when the blue globule (in case indigo is employed to feed them) has attained a certain size, its own weight and the current from without seem to force it into the substance of the body. Here it remains fixed, and, with the exception perhaps of a slight change of position as the body becomes filled with globules, it does not move—certainly the food does not rotate.

The contractile vesicle is situated at the end opposite the mouth, and as the animalcule becomes developed a system of smaller ones, into which the fluid contents of the larger one are forced when the latter contracts, makes its appearance. If a young *Glaucoma* be dried up the contractile vesicle emits rays or beams, which widen as their distance increases from the central vesicle. Sometimes more than one large vesicle are visible. I have seen a discharging orifice in *Glaucoma*, but could not always distinguish one; probably one is always present.

Glaucoma reproduces by self-division. I have never seen any but *transverse* fissuration, and that frequently. That another reproductive process exists is certain from the fact that *Glaucoma* is developed from germs, and this, along with the further development of the animal, I shall endeavour at some further time to elucidate.—James Samuelson, Hull.

Colour of Blood Corpuscles.—In the description usually given of the *coloured corpuscles* of the blood, I discover an error which ought not to remain uncorrected.

Thus Kölliker ('Microscop. Anat.,' b. ii, p. 356), "Die Farbe der Blutzellen ist nicht roth wie die des Blutes, sondern blassgelb, und zwar aus physikalischen Gründen heller bei ganz abgeplatteten, etwas dunken bei mehr aufgequellenen zellen."

Henle also ('Anat. Générale, t. i, p. 457, trad. Jourdan, 1843) says that, "Les corpuscules coloris du sang se distinguent sur-le-champ par leur couleur jauneâtre."

Now I am perfectly aware that the above appearance is given by some authors as presenting itself under the microscope, but less distinguished writers make no mention of the condition under which the yellow colour is observed, and most elementary "text-books" of physiology for students convey the idea that the coloured corpuscles are actually of a faint yellow hue.

Now it stands to reason that no amount of *yellow* discs can produce the intense *scarlet* of human blood; on the contrary, I hold it as a positive fact that the colour of each particular flattened, circular, or oval disc of mammifer, bird, reptile, batrachian, or fish, is as deep and vivid as the mass of the blood of which it is a constituent part. The *scarlet* disc of man, when magnified by 500 diameters, fades almost to a pale straw colour; for, as you know perfectly well, the crimson that painted a surface the $\frac{1}{0{\cdot}8000}$th (about) of a square line is diffused over a superficial extent of not less than 2·10 square lines, which is a chromatic *dilution* of 142·800 times. It is not, therefore, surprising that the homœopathic quantity of red in the amplified image, besides *loss*, should hardly be recognised as such.

Suppose fl℥, 3·2, of fresh blood in a flat-bottomed glass vessel, 1·5 inch wide (cylindrical); the mass will have nearly the proportions of a blood disc, and a bright scarlet hue. Imagine, now, the same blood in a similar vessel, 750 inches wide, and thinned out with transparent syrup, of the specific gravity of the blood, until the mixed fluid would stand 150 inches high in the glass; would not this liquor, when viewed from above, give the same impression of colour to the eye as a single blood-corpuscle as seen "under the microscope," with a power of 500.

I beg to say, that I believe the error just pointed out in descriptions to exist only in the terms used, without care being had to explain why the *red corpuscles appear* faintly yellow; but this inadvertence is calculated to mislead professional men, and even some professors in this country, who teach physiology entirely from books.—CHRISTOPHER JOHNSTON, M.D., Baltimore, U.S.

Use of the Microscope.—The following case is so interesting a triumph for the microscope that I send it for your perusal, and insertion, if you please, in the 'Journal.'

A few days ago a medical friend told me of a patient who was then passing very large quantities of fat in her evacuations, and who had been doing so for a long time; he offered

to procure me some of the material for microscopic examination, and shortly afterwards I received a specimen. It seemed very similar in appearance to a coarse butter, was soft, and easily broken down, but it was dense, and sank in water. On examining it with a half-inch object-glass not a single fatty globule could be seen; neither did ether extract any oil. The mass consisted of a great number of large cells loosely aggregated, each had a clear transparent wall, without a visible nucleus, and contained a light brown granular mass, but which was separated from the cell-wall by a transparent medium. Average size of cell $\frac{1}{100}$th of an inch. It was clear that the material more closely resembled vegetable than animal structure, and the accidental discovery of a fragment of fibro-cellular tissue strengthened the idea. I then boiled a portion, and on the addition of iodine procured a dense precipitate of iodide of starch. My next step was to examine the mealy potato, as served at table. The size of the cells was the same, but all were empty, or filled only with a transparent fluid, and were puckered on the surface. The presence of the granular mass in the others seemed to indicate that the potatoes had been either uncooked or insufficiently boiled, the idea of their being taken *raw* seemed incompatible with the loose state of aggregation in which the cells were found. I hazarded the opinion that the patient ate largely of mashed potatoes, and evidently was a sufferer from a weak digestion, as she was unable to digest the starch they contained. I was then told that the case was one of long-continued dyspepsia, with an excessively irritable state of the stomach and bowels, that the lady could only take farinaceous food, and the doctor did not believe she took any potatoes in any way. The symptoms and "fatty" dejections had lasted for years. I assured my friend that there could be no moral doubt about the facts as revealed by the microscope, and next day I received a note from him to the following effect:

"Dear I.,—I have seen the lady, and you will be gratified to hear that for a very very long time she has almost lived upon mashed potatoes crushed small" (not boiled).

I need scarcely add a word upon the flood of light thus thrown by the microscope upon what otherwise would have been veiled in great mystery;—the facts speak for themselves. —T. Inman, M.D., Liverpool.

Conjugation of Diatomaceæ.—I have had a large stock of *Navicula amphisbæna*, in several gatherings, this summer from the Thames, at Weybridge, and have three times distinctly witnessed the following phenomenon, viz., what I suppose to be the formation of a sporangium by the joint conjugation of three and four frustules, as in Cosmarium, and some other species of *Desmidiaceæ*.

The frustules, three in two cases and four in the other, were attached to the sporangium by a short stipes proceeding from the centre of the lateral suture of each.

In two of the cases the endochrome had been discharged from all; the frustules in the third, in which four frustules were attached to the sporangium; one retained the endochrome, which entirely filled the lorica, and was of higher colour, and more condensed appearance than is presented by the species in its ordinary aspect.

Is it possible this frustule may have been antheridial? This is only an idea.

The sporangial frustule was marked in a series of nodules not unlike in appearance—though but just discernable with Ross's ¼-inch—the cells of a section of Echinus spine. I had not the good fortune to trace the development of the sporangium, having only seen it apparently near its perfection, nor have I, in consequence of leaving Weybridge, and my stock having been inadvertently thrown away, been able to follow its further history.—THOMAS CHARLES DRUCE, Chelsea.

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *May 28th*, 1856.

George Shadbolt, Esq., President, in the chair.

James Glaisher, Esq., Lewisham, was balloted for, and duly elected a member of the Society.

A Paper, by Mr. Wenham, "On the Vegetable Cell," was read.

June 25th, 1856.

George Shadbolt, Esq., President, in the chair.

J. S. Bolton, Esq., Brixton Hill; Hon. R. H. Meade, Belgrave Square; and the Rev. A. B. Cotton, Keppel Terrace, Windsor, were balloted for, and duly elected members of the Society.

A Paper, by Dr. Davey, "On the Structure of *Bryonia dioica*," was read.

A Paper, by the Hon. and Rev. S. G. Osborne, "On Vege-Growth in the Wheat Plant," was read.

A Report from the Committee on Finders was read.

ZOOPHYTOLOGY.

At the Meeting of the British Association, at Cheltenham, a "Notice," by Mr. J. Alder, was read of several new species of *Hydrozoa* and *Polyzoa*, found by him on the coasts of Northumberland and Durham. The entire number of species described amounted to thirteen, but we are here able to give only those belonging to the class *Polyzoa*,—four in number.

Class. Polyzoa.

Ord. *P. infundibulata.*

Sub-ord. *Cœnostomata* (*s. Vesicularina*).

1. Fam. *Vesiculariadæ.*

Gen. 1. *Buskia*, Alder, nov. gen.

Polyzoary corneous, consisting of a slender, tubular, creeping fibre, with cells developed at intervals. Cells ovate, adhering through their whole length; generally with lateral spine-like processes, also adhering; orifice terminal and circular. Polypide with eight tentacles, issuing from a sheath of fasciculated setæ.

B. nitens, Alder, n. sp. Pl. XIII, figs. 1, 2.

Minute, horn-coloured, shining; creeping fibre filiform, branching or anastomosing, with occasional short spinous offsets; cells ovate or flask-shaped, rather ventricose, tapering towards the orifice, the margin of which is thickened, and slightly nodulous; sides of the cells produced into irregular spines adhering to the substance on which it creeps. Length of cell, $\frac{1}{30}$th inch.

On *Plumularia falcata*, *Campanularia plumosa*, &c., from deep water, Northumberland coast, rare.

This interesting little zoophyte has probably hitherto escaped observation from its minuteness. The spine-like processes at the sides give the cells an insect-like appearance; they are irregular and occasionally wanting. The cells are also subject to some variation in form, especially in the size of the aperture; they lie nearly parallel to the stem, which frequently divides, and runs along each side of them, clasped by the lateral processes.

Farrella pedicellata, n. sp. Pl. XIV, figs. 1, 2, 3.

Body ovate-oblong, yellowish, transparent, with long and very slender pedicles, uniform in thickness throughout; tentacles 12. Length of cell, $\frac{1}{30}$th inch.

On old shells of *Buccinum undatum* and *Fusus antiquus*, from deep water, Cullercoats; not uncommon.

This species differs from the *Laguncula* (*Farrella*) *elongata* of Van Beneden, in the great length and slenderness of the pedicle, which is usually two or three times the length of the cell, and does not enlarge towards the top, as in the latter species. The cells are rather narrower above than in *F. elongata*, and the number of tentacles does not exceed twelve in any of the specimens that I have examined. The animal, as seen through the transparent cell-walls, is of a pale yellowish colour, with a brownish red patch, indicating the position of the stomach. The ovaries are white. The base of the cell is finely wrinkled, and at its junction with the pedicle it forms a kind of joint, which can be more or less twisted at the will of the animal.

2. Fam. *Alcyonidiadæ.*

Alcyonidium mamillatum, n. sp. Pl. XIII, figs. 3, 4.

Encrusting, semitransparent, brownish, covered with rather long, stout, and strongly wrinkled papillæ, from which the polypides issue; tentacles 16 or 18.

On old shells from deep water, Cullercoats; not uncommon.

When carefully examined this species can be readily distinguished from those hitherto known by the greater size and elevation of the papillæ, which, although varying much in length, according to their state of contraction, are always sufficiently prominent to be easily recognised. When most contracted they appear like strong mamillæ, but their more usual form, when the polypide is withdrawn, is elongate-conical; when it is expanded, they are cylindrical and nearly linear. This species is parasitical on old univalve shells, which it envelopes with a sub-coriaceous crust, never rising into a free state. No septa are visible excepting in the margin of young specimens, or when examined as a transparent object in the microscope.

Alcyonidium albidum, n. sp. Pl. XIII, figs. 5, 6.

Encrusting, semitransparent, yellowish white; general envelope inconspicuous; polypides prominent, ventricose, flask-shaped, sub-recumbent, becoming erect towards the aperture, which is truncate when contracted; tentacles 18.

Surrounding the stem of *Plumularia falcata* in small patches; from the deep-water fishing boats, rare.

This species looks somewhat like a cluster of separate animals; the polypides being prominent and united to each other by narrow septa, which are scarcely perceptible. When the polypide is extended it is columnar, tapering slightly upwards, and expanding into a slight ridge below the fasciculated sheath.

ZOOPHYTOLOGY.

DESCRIPTION OF PLATES.

Plate XIII.

Fig.

1.—*Buskia nitens*, highly magnified.

2.—Two cells of the same; the upper one showing part of the polypide with the sheath of setæ.

3, 4.—*Alcyonidium mammillatum*, natural size and magnified.

5, 6.—*Alcyonidium albidum*, natural size and magnified.

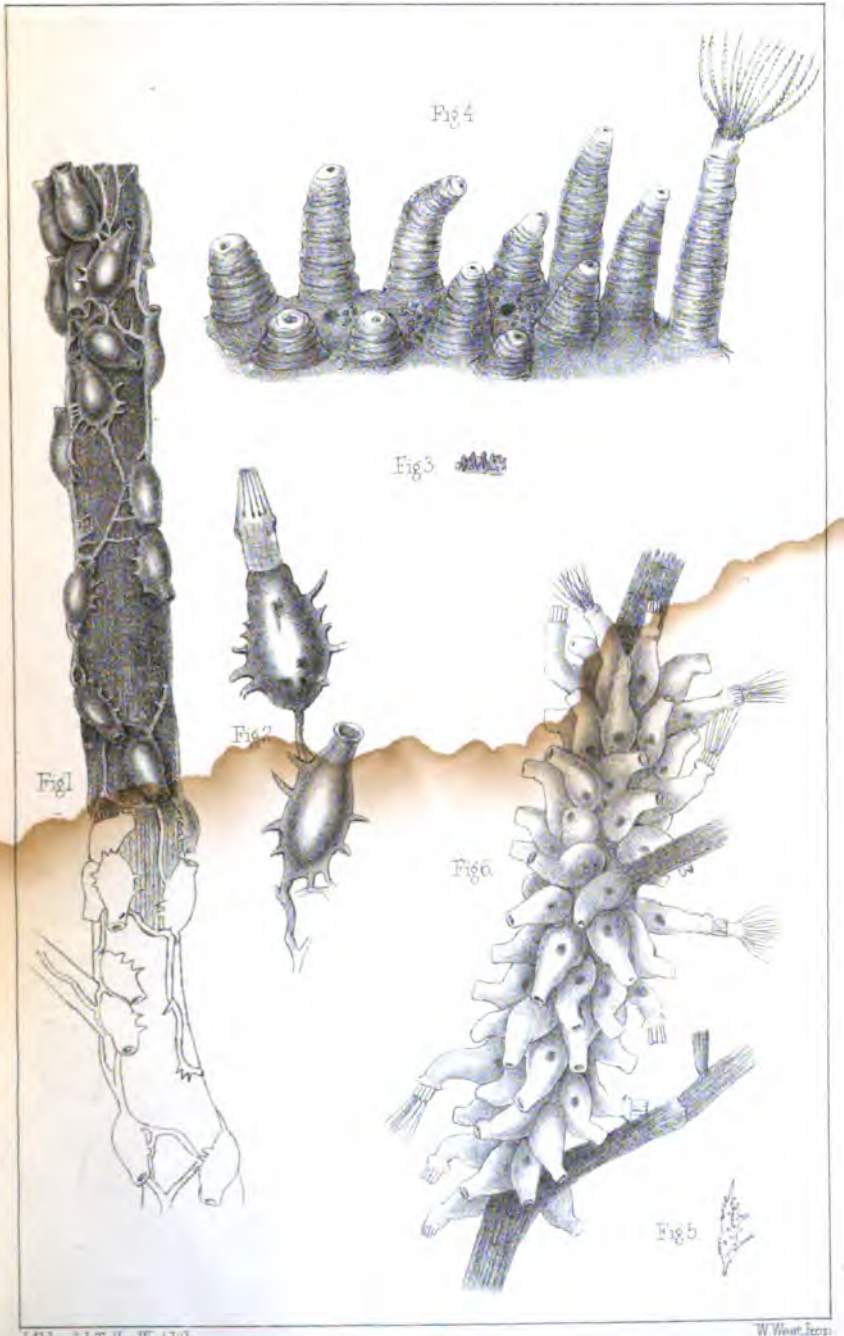
Plate XIV.

1.—*Farella pedicellata*, highly magnified.

2.—A cell with polypide withdrawn, more highly magnified.

3.—The same with the polypide expanded.

Plate XIII



J. Alder del. Tuffen West lith.

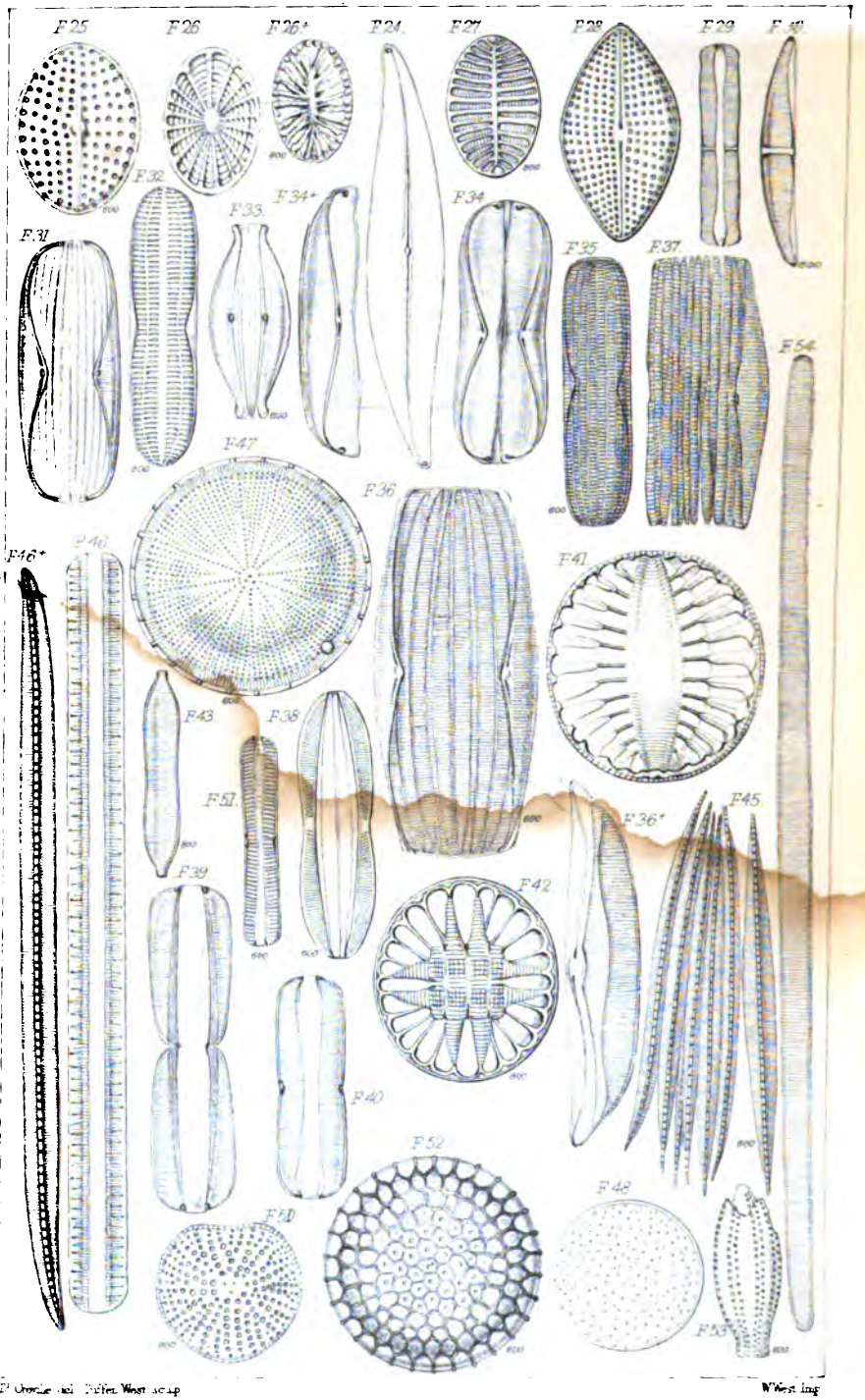
W. West Imp.

ZOOPHYTOLOGY.

Plate XIV.

J.Allen del. Tuffen West Lith.

Wilson sc.



P. Oswald del. Pitter West sc. & p

W West imp

DESCRIPTION OF PLATE I,

Illustrating Professor Gregory's paper on the *Diatomaceæ* of the Glenshira Sand.

Fig.
24.—*Pleurosigma*, not named, sp.?
25.—*Cocconeis distans*, n. sp. × 600.
26.—*Cocconeis radiata*, n. sp. × 800.
26*.— „ „ „ Abnormal form of the same.
27.—*Cocconeis costata*, n. sp. × 800. This is a small specimen.
28.—*Cocconeis lamprosticta*, n. sp.
29.—*Amphora rectangularis*, n. sp.
30.—*Amphora elegans*, n. sp. A detached valve. × 600.
31.—*Amphora plicata*, n. sp.
32.—*Amphora biseriata*, n. sp. × 600.
33.—*Amphora lineata* ? n. sp.? × 600.
34.—*Amphora obtusa*, n. sp.
34*.— „ „ A detached valve.
35.—*Amphora crassa*, n. sp. × 600.
36.—*Amphora Grevilliana*, n. sp. × 600.
36*.— „ „ A detached segment.
37.—*Amphora Arcus*, n. sp., showing many segments in apposition. The detached segments are figured in my first paper on the Glenshira Sand. See 'Quarterly Journal of Microscopical Science,' vol. iv, Pl. IV, fig. 4.
38.—*Amphiprora minor*, n. sp. × 600.
39.—*Amphiprora lepidoptera*, n. sp. The front view. (The side view is figured in the plate above referred to (under fig. 37) as *Amphiprora vitrea*, β?) This specimen is from ⅓ to ½ shorter than what I now find to be the average length of this fine species.
40.—*Amphiprora* ? *recta*, n. sp. The second figure, mentioned in the text, is omitted for want of room.
41.—*Campylodiscus simulans*, n. sp.
42.—*Campylodiscus bicruciatus*, n. sp. × 800.
43.—*Tryblionella apiculata*, n. sp.? × 800.
45.—*Nitzschia* ? *socialis*, n. sp. × 600.
46.—*Nitzschia insignis*, F. V., n. sp.
46*.— „ „ S. V., „
47.—*Eupodiscus sparsus*, n. sp.? × 600.
48.—Disc, not named, n. sp.?
50.—Disc, not named, n. sp. × 600.
51.—*Amphiprora* ? not named, n. sp.? × 600.
52.—Disc, probably one of the *Polycystineæ*. × 600.
53.—Oval form. Diatomaceous ? or one of the *Polycystineæ* ? × 600.
54.—*Synedra Baculus*, n. sp.

Figs. 44, *Nitzschia distans*, and 49, a disc, not named, have been omitted for want of space, but will be given on a future occasion.

Although many of the above figures are magnified to 600, and some to 800 diameters, yet they all vary in size to such an extent that specimens might have been selected which, magnified 400 diameters, would have been of the same length as the figures.—W. G.

The figures to which no mark of the magnifying power is attached are drawn to a scale of 400 diameters.

DESCRIPTION OF PLATE II,

Illustrating Mr. Dobson's paper on Lerp.

Fig.

1.—Ova of *Psylla* ?

2.—Larvæ constructing the conical crusts of lerp.

3.—The scaled form of lerp.

4.—The *Psylla* which affords the white lerp.

5.—Different forms of yellow lerp.

6.—The species of *Psylla* which produces the yellow lerp.

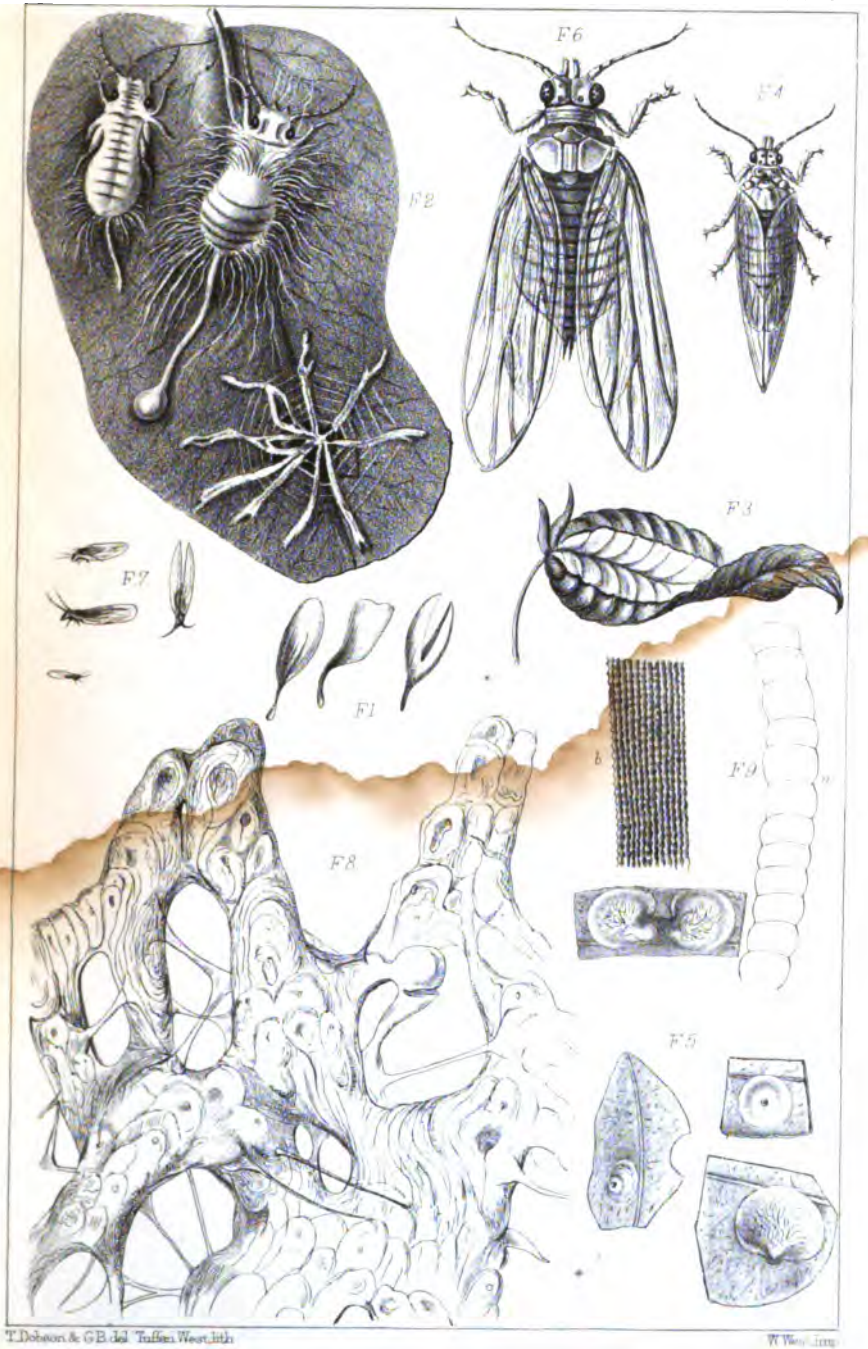
7.—The various species of *Psylla* affording lerp. Nat. size.

8.—Portion of the edge of a crust of yellow lerp. Magnified 30 diameters.

9.—Hairs on the crusts.

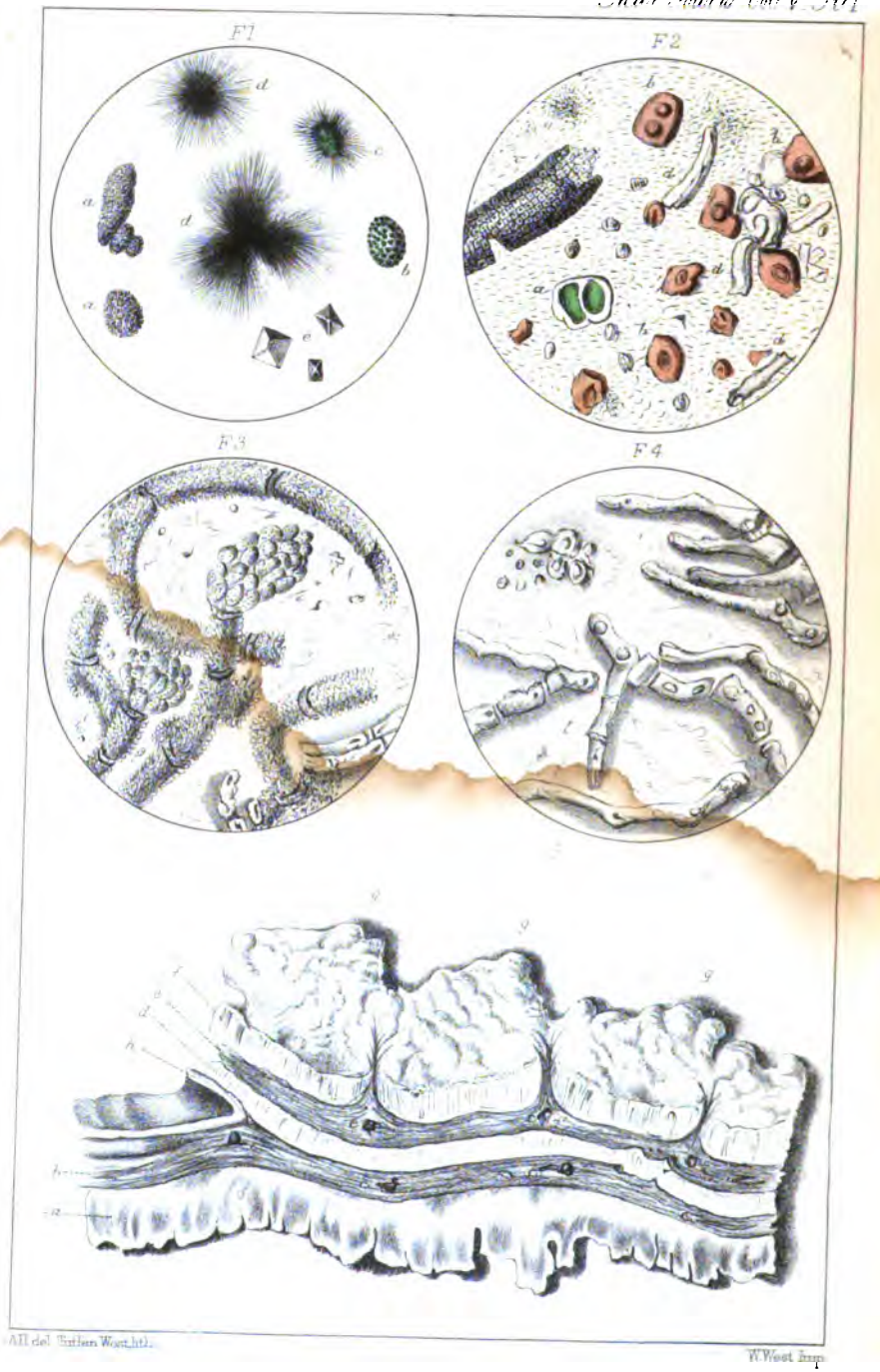
a. Towards the apex.

b. Towards the base.



T. Dobson & G.B. del. Tuffen West, lith.

W. West, imp.



All del. Tuttlen West lith.

W. West Imp.

DESCRIPTION OF PLATE I,

Illustrating Mr. Hepworth's paper on the Practical Use of the Microscope.

Fig.

1.—*aa.* Exudation corpuscles.

b. The same, having undergone a slight change.

c. The same, having undergone a further change.

dd. Fully developed vegetations.

e. Crystals of oxalate of lime.

2.—*a. Sarcina renis.*

bb. Epithelial scales.*

c. Part of one of tubuli uriniferi.

d. Casts of ditto.*

3.—Aphthæ from a case of consumption.

4.—Ordinary aphthæ (thrush) in children.

5.—Longitudinal section of diseased intestine.

a. Thickened scirrhous peritoneal coat, the outer portion being dark brown, fibrous, and striated, the striæ being transverse to the section.

b. Outer cellular tissue containing—

cc. Blood-vessels.

d. Outer aponeurosis of what should have been the muscular coat.

e. Cellular tissue (in place of muscular coat, which was wanting) passing at intervals through—

f. The inner aponeurosis of muscular coat.

ggg. Masses of coagulable lymph.

h. Reflected mucous membrane.

* The epithelial scales and casts were not from the same subject; it is from a drawing I took some time ago, and having often met with scales of this colour with casts, I have introduced it here.

DESCRIPTION OF PLATES III, IV, V,

Illustrating the Hon. and Rev. S. G. Osborne's paper on Vegetable Cell-formation, principally as shown in the Growth of Wheat.

PLATE III.

Fig.

1.—Seed of wheat germinating, slightly enlarged.
- A. Green future blade, &c.
- B. Seed, starch, gluten, &c.
- C. Main root.
- DD. Lateral roots.
- EEE. Free cones of cells at the points of the roots.
- F. Hard cellular matter, the base of growth of root and stem.
  - α. Cellular tissue, the original covering of embryo blade.
  - β. Ditto of root.
  - γ, γ. Rootlets.
  - δ. Course of bundle of dotted fibre.
  - ε, ε, ε. Suckers.
  - ζ. Course of spiral fibre.

2.—Section from junction of germ with seed.

2 *a*.—The sap-tube on a larger scale.

3.—Thick-walled cellular tissue, with dark granular matter and oil, connecting the bundles of fibre and their investing cells with the germinating point.
- *ab*. Layers of cells in immediate connection with—
- *c*. Thick-walled cells containing oil.

4.—Termination of rootlet slightly magnified, with its free capsule of cells, *d*, and suckers.

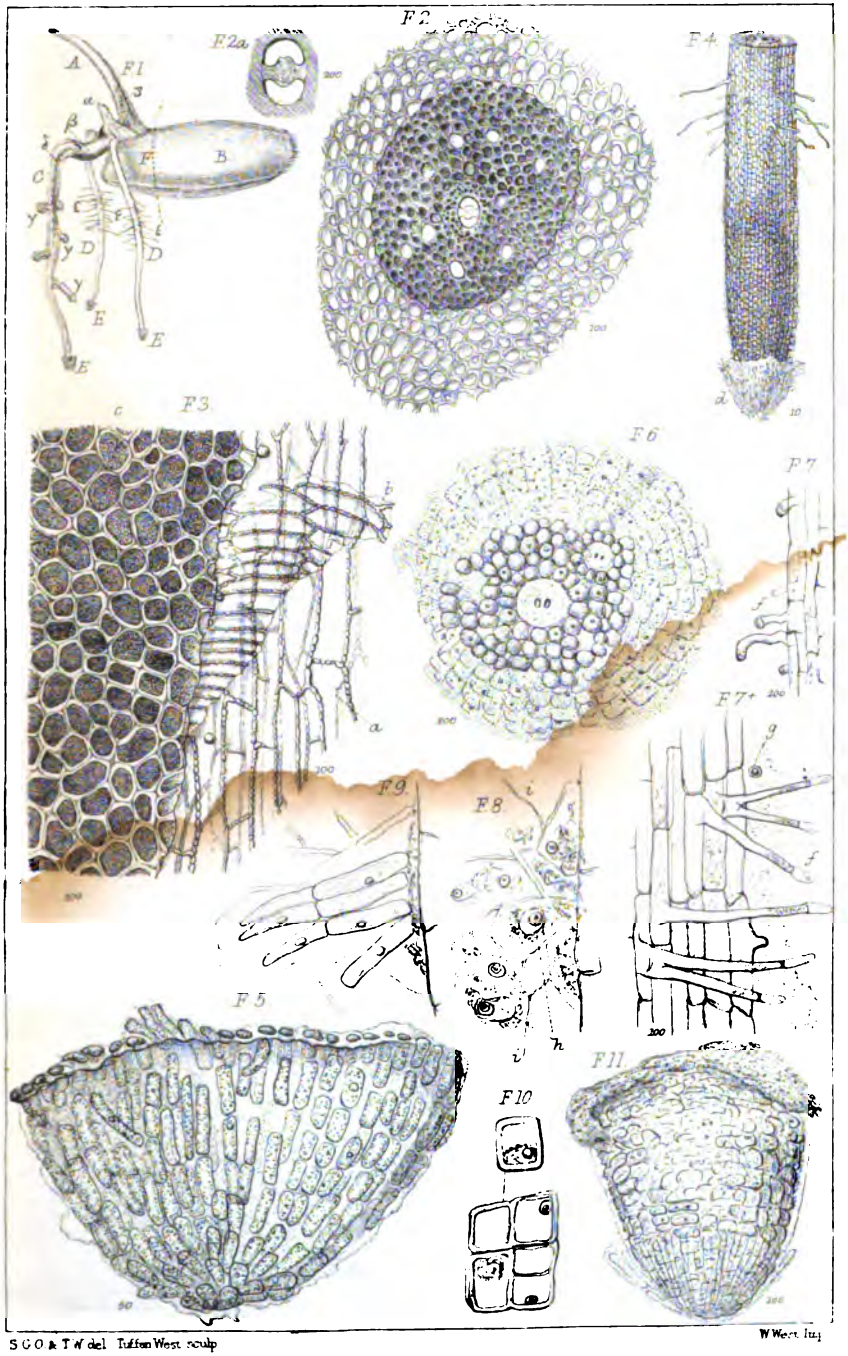
5.—Capsule enlarged.

6.—Centre of apex of young root.

7, 7*.—Stages of growth of suckers from side of root.
- *f*. Suckers.
- *g*. An escaped nucleus with its nucleolus.

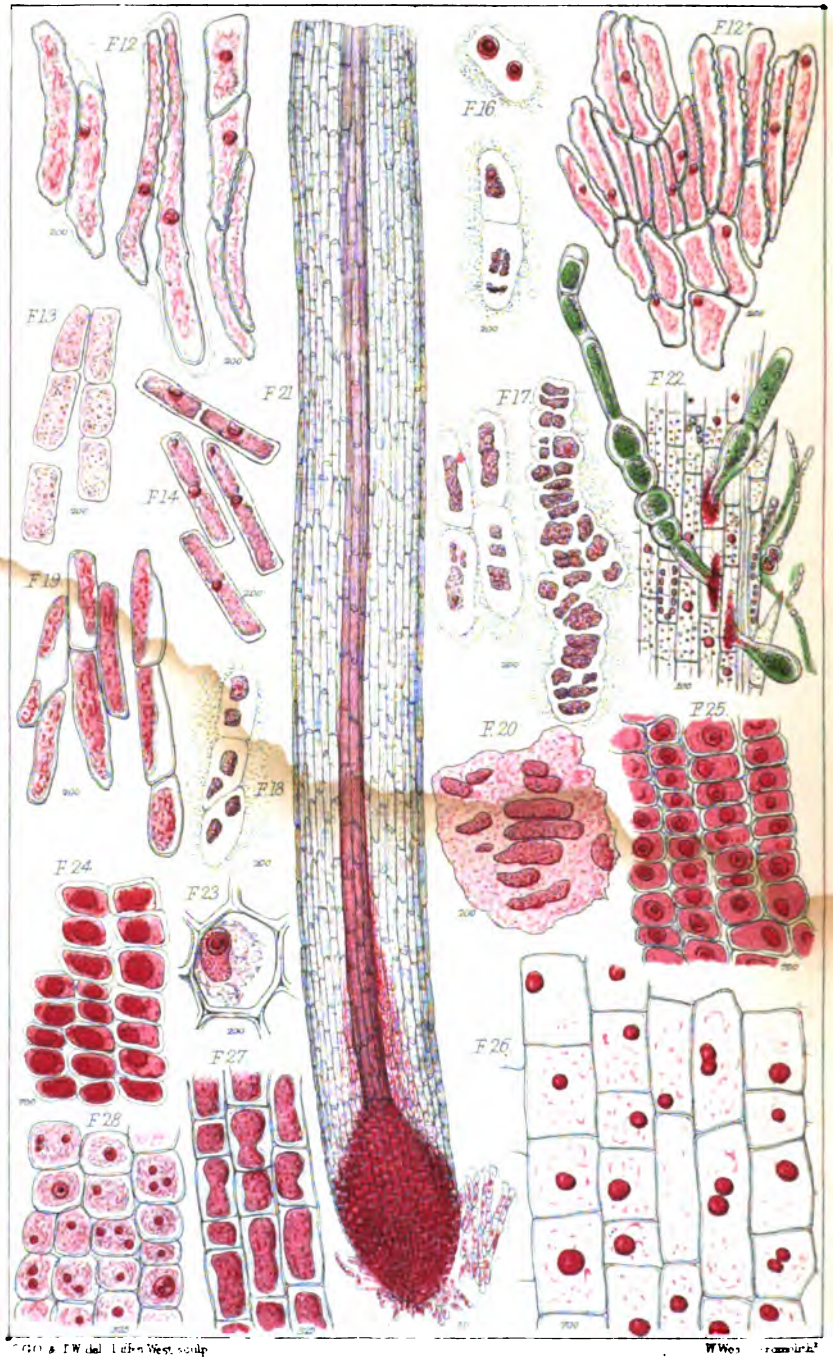
8, 9.—Growth from side of root.
- *h*. Nuclei in egg-shaped vesicles.
- *i*. Hyaline thread-like processes.

10.—Cell-increase.



S G O & T W del Tuffen West sculp

W West lith



Geo. & J. W. del. Luther West sculp.

W. West & Son Birmingham

PLATE IV.

Fig.
12, 12*.—Capsule cells.

13.—Capsule cells, without nuclei.

14.— „ „ nuclei formed; cell-increase proceeding by sub-division.

16, 17, 18.—Very earliest stages of cell-formation.

19.—Cell-increase by recession of granular contents to one side,—as displayed by colouring.

20.—Early cell-formation, coloured.

21.—Lower portion of a root of wheat coloured; the capsule-cells strongly painted; the pith-tube coloured; the colour decreased as growth proceeds; the parenchyma colourless.

22.—Absorption by a parasitic fungus, of coloured matter taken up by Anacharis.

23.—Shows well the nucleus with its nucleolus, in the "ovate vesicle;" from the large cell-structure surrounding the "sap-tube."

24.—Commencing formation of nuclei, and consequent increase in depth of colour, from base of a maize root.

25.—Nuclei perfectly formed, cell-contents reduced in quantity and depth of colouring.

26.—Taken from a little higher up the root. Nuclei alone left, the cell-contents having more or less disappeared.

27.—Cell-growth by the formation of a septum or septa, dividing individual cells into two or three; the walls frequently seem to be composed of several layers of plasma maize.

28.—Cells containing double and triple nuclei, sometimes two in one vesicle.

PLATE V.

Fig.

29.—Young leaf of wheat; it is seen to possess the free capsule of cells and epidermic plasm, closely identical with those of the root.

29*.—Portion of edge of the above much magnified.

30.—Some of the free cells from the above, detached.

31.—Transverse section of embryo leaf folded, with its straw-coloured envelope.

32.—Double ovate granules and molecules, showing a tendency to regular arrangement; from formative matter at an early age.

33.—Appearance of nuclei with nucleoli and vesicles, in formative matter at a stage more advanced than the last.

34.—Cells increasing by sub-division; from maize-leaf.

35.—Annular, spiral, scalariform, and pitted vessel, in juxtaposition; maize.

36.—Early formation of pitted vessel; maize.

37.—Dark spots indicating the commencement of actual perforation of the delicate membrane at the base of the pits in a "pitted" vessel; maize.

38.—Progress of absorption of basement membrane, spirally; maize.

39.—Transverse section, root of maize, showing the pentangular form assumed by scalariform tissue, through pressure of the surrounding cell-structure.

40.—Scalariform vessel from young cucumber, unrolling; its pentangular form is thus very distinctly brought out.

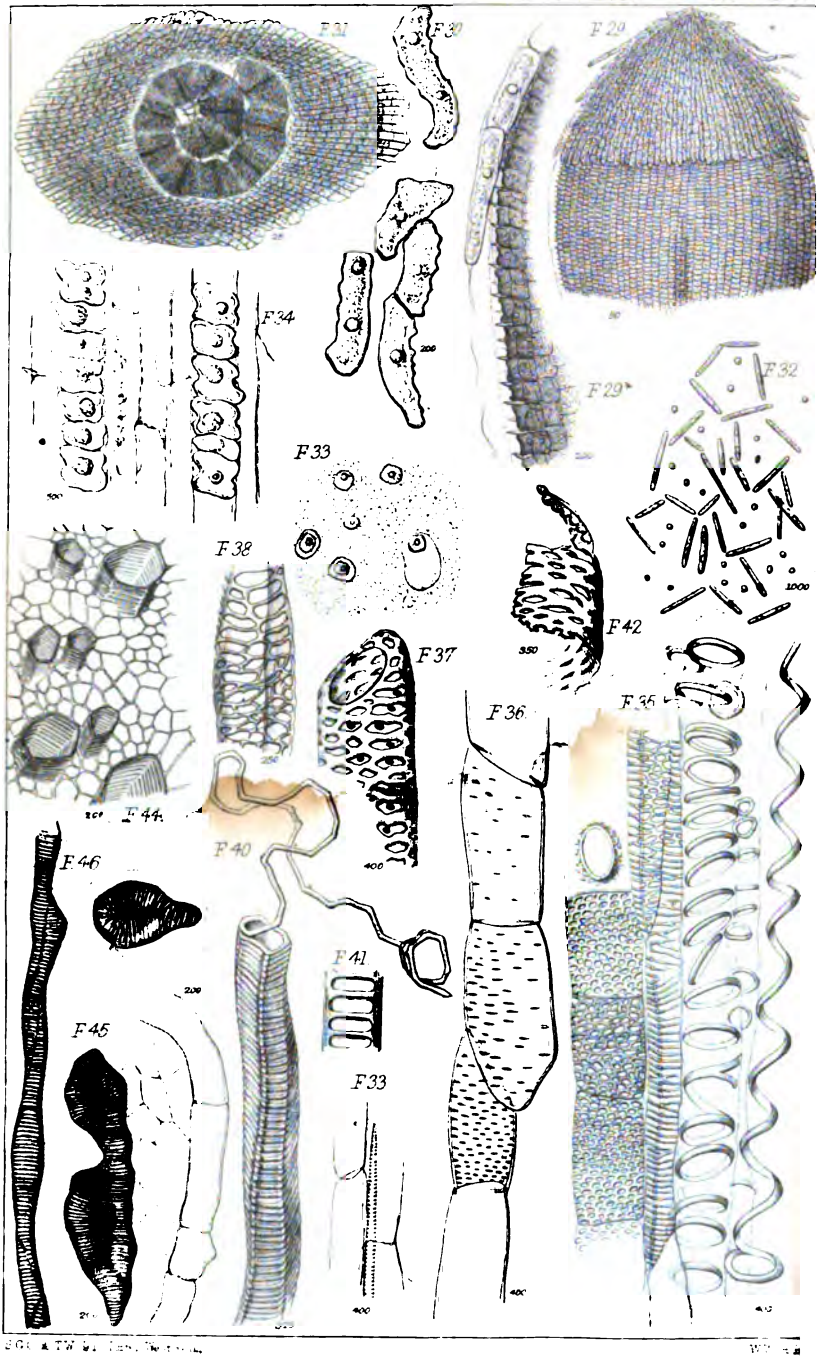
41.—Absorption of basement membrane in a linear direction, in the production of an annular vessel.

42.—Transverse section of a pitted vessel, a portion of the cut edge projects and shows well the production of the "pits," also lines indicating the layers of secondary deposit on the cell-wall.

43.—Rudimentary spiral fibre; plumule of wheat.

44, 45.—Early stage in formation of scalariform tissue; young vegetable marrow.

46.—The same, showing formation of a scalariform vessel, by the addition of cell to cell, and absorption of their walls at the points of contact.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ORIGINAL COMMUNICATIONS.

MONOGRAPH *of the* GENUS ABROTHALLUS (De Notaris *and* Tulasne *emend.*) By W. LAUDER LINDSAY, M.D., Perth.

(Read before Section D. of the Meeting of the British Association, at Cheltenham, in August, 1856.)

THE genus Abrothallus, and especially the species hereafter described as *A. Smithii*, have long been familiar to lichenologists under a variety of designations; but their true structure and place in classification were quite misunderstood until the comparatively recent researches of De Notaris,* in Italy, and Tulasne,† in France. *A. oxysporus* (*infra descript.*) has generally been regarded as a species of *Endocarpon*, especially when it bore only young apothecia; while the apothecia of *A. Smithii* have been denominated *cephalodia*, and have been variously looked upon as the abortive, monstrous, or accessory apothecia of certain Parmelias, Lecideas, and other lichens, or as parasitic fungi. Sir William Hooker, in his 'British Flora,' vol. ii, p. 200 (1833), says that *Parmelia saxatilis*, and its variety *omphalodes*, "are liable to be infested with a parasite, which has been called *Endocarpon parasiticum*, Ach." ('E. Bot.,' t. 1866.) On furfuraceous states of *P. saxatilis* the Abrothalli are most abundant. In his 'Flora Scotica' (part ii, p. 44, 1821), Hooker gives as the characters of this *Endocarpon parasiticum* (*Lichen parasiticus*, 'E. Bot.,' t. 1866): "Thallus coriaceous, convex, rounded, lobed, copper-coloured, at length rugged, black and shaggy beneath, orifices scattered, sunk, minute, coal-black, at length convex." This description, in so far as it applies to the apothecia, appears to confound the two species *A. Smithii* and *A. oxysporus*; and, in so far as it describes a thallus, it is erroneous, since recent researches have proved the genus Abrothallus to be really athalline. The latter error, however, is rectified in the 'British Flora,' p. 159, where it is stated that the "*Endocarpon parasiticum*, Ach., is now universally considered to be a portion of the thallus of *Parmelia saxatilis* or *omphalodes* deformed by a parasite." The view

* 'Mem. della reale Accad. delle Sc. di Torino,' ser. 2, vol. x, p. 351 (1849); and in 'Giorn. bot. Ital.,' ann. ii, fasc. iii-iv, part i, p. 192, (1846).

† "Mémoire pour servir à l'Histoire organographique et physiologique des Lichens," in the 'Annales des Sciences Naturelles,' ser. 3, Botanique, vol. xvii (1852), p. 112.

that the Abrothalli are abortive apothecia of certain familiar foliaceous lichens is maintained so lately as 1850 in Schærer's elaborate 'Enumeratio critica Lichenum Europæorum,' (Berne, 1850). He describes the species mentioned by Hooker as *End. parasiticum*, under the name of *Parmelia saxatilis*, var. *parasitica*, in the following terms: "Thallo supra apotheciis abortivis, atris, subpatellæformibus vel hemisphæricis, immarginatis, consito." His description of the var. *abortiva* of *Parmelia conspersa* is precisely similar. Of *Parmelia olivacea*, var. *abortiva*, he says, "Thallo supra sphærulis atris (apotheciis abortivis) distincto." These are characteristic descriptions of *A. Smithii*, the variety which I have hereafter described as α, *ater*. To my variety *pulverulentus* of the same species, he refers, sub nom. *Sticta fuliginosa*, var. *abortiva*, when he says: "Thallo supra patellulis superficiaribus, olivaceo-viridi-pulverulentis, immarginatis, distincto." Schærer's specific and generic characters have too evidently been founded wholly on external appearances: he himself deplores his deficient microscopical knowledge and skill. But he does not appear to have been aware of—or at least he does not allude to—the researches of De Notaris on the genus Abrothallus, which bear date between the years 1846 and 1849,—prior to the publication of his own 'Enumeratio.' Of Tulasne's investigations he could not avail himself, as they were published two years subsequently. By other observers, again, there has been too great a tendency perhaps to take for granted the bold and sweeping assertion of Fries that "Lichenes in aliis parasitici normaliter nulli genuini,'—an assertion whose incorrectness the labours of subsequent observers have sufficiently proved. It has been too much the custom lazily and ignorantly to refer minute, black, point-like or spot-like parasitic lichens to the great family of the Fungi; but I feel assured that many species of Sphæria, Dothidea, Peziza, and other fungi, presently so-called, which are parasitic on the thallus of various familiar lichens will ultimately be found to belong themselves to the ranks of the lichens. I attribute, however, no blame to my predecessors for having erred in regard to the structure and place in classification of these minute organisms. Nay, I do not see how such errors could have been avoided; for the parasitic lichens, to which I refer, could not have been properly studied prior to the introduction of the microscope. I believe it to be too common now-a-days to depreciate the labours of the earlier botanists; but the more we study the minuter Cryptogams the more must we become convinced of the extent, accuracy, and value of

their observations. Most of the organisms with which we are now acquainted were noticed and described by them; and we cannot hold them altogether responsible for the misinterpretation of their nature and alliances.

While studying the furfuraceous and other abnormal states of the thallus of the common *Parmelia saxatilis*, in various localities in the neighbourhood of Perth, during the past spring, I was struck by a peculiar deformation or anamorphosis of the thallus, which I first found in abundance on a damp, shady, old wall on Craigie Hill, Perth. An examination of the lichen soon convinced me that the deformation was the seat, if it was not also produced by the growth, of a parasitic lichen, and that this parasite consisted of the *Abrothallus Smithii*, *A. Welwitzschii*, and *A. oxysporus* of Tulasne. The unusual interest connected with this genus on many accounts led me to look carefully for it in similar habitats elsewhere. I have since succeeded in finding these species in comparative abundance in many parts both of the Highlands and Lowlands, more especially of the former. I have recently examined microscopically about 250 specimens, chiefly from Highland districts, comprising both species in every state and stage of growth. In the majority of cases the habitat was old roadside walls—chiefly built of rocks or boulders belonging to the primitive or metamorphic series. In a comparatively small number of instances, the matrix grew on loose boulders of the same rocks; and in a still less number on trees, especially the ash and alder. In all cases the parasites grew on furfuraceous forms of *P. saxatilis*. From the frequency with which I have gathered the Abrothalli in the Highlands and Lowlands of Scotland, I have no hesitation in asserting that, if carefully looked for, they will probably be found comparatively common in Wales and Ireland, and—to a less extent perhaps—in England,—especially the hilly parts thereof. In addition to the Abrothalli collected by myself, I am indebted to the kindness of the Rev. W. A. Leighton, of Shrewsbury, for specimens,—chiefly of *A. oxysporus*, growing on *Cetraria glauca* and *Parmelia conspersa*, as well as on *P. saxatilis*, from Barmouth, North Wales. And lastly, I possess, in Leighton's 'Lichenes Britannici exsiccati' (fasc. ii, No. 46), specimens of *A. Smithii*, Tul., growing on furfuraceous states of *P. saxatilis*, from the Wrekin, Shropshire; and (fasc. vi, No. 191) of *A. Welwitzschii*, Mont., on *Sticta fuliginosa*, from rocks, New Cut, Meadfort, Torquay, Devonshire. These specimens have therefore afforded me ample facilities for investigating, by the aid of the microscope and chemical reagents, the anatomy of the

genus Abrothallus. My results, though in the main corroborative of the admirable descriptions of Tulasne, lead me to take a somewhat different view of the numbers and characters of the species; while they enable me to rectify or supply various of his minor errors of commission or omission. For example, Tulasne speaks of the "Spermogoniæ ignotæ;" and, so far as I am aware, no previous or subsequent author (for, in Körber's 'German Lichenography,' published during the present year, the spermogones are stated "in der gewöhnlichen Form bei Abrothallus zu fehlen scheinen" *) has observed, or at least described, the spermogones of Abrothallus, which I have been fortunate enough to meet with several times. But I have other and perhaps stronger grounds for bringing the anatomy of Abrothallus under the notice of British botanists. It is destitute of a thallus; is parasitic on another living lichen; and is possessed of the accessory reproductive bodies, *stylospores*, contained in conceptacles resembling in structure and site the spermogones, and termed by Tulasne *pycnides*. In each of these respects, the genus is peculiar and deserving of special study. I believe that a knowledge of the origin, structure, and mode of development of the deformations of the thallus of *P. saxatilis*, on which the Abrothalli grow, will assist us in explaining the nature of certain so-called erratic lichens, which have been lately discovered. British botanists have very recently been much puzzled to account for the origin of a curious globular Parmelia, found by Sir W. C. Trevelyan, bowling freely before the wind along the surface of the soil on the exposed chalk downs of Dorsetshire. A careful examination has led me to the conclusion that this wandering Parmelia is merely a hypertrophied condition of the deformed thalli in question. Until within the last few years, botanists were almost unaware of the existence of lichens parasitic on other species. Even yet our knowledge of parasitic lichens is exceedingly incomplete. The list of British species is very meagre; but the patient labours of such men as Leighton, of Shrewsbury, and Mudd, of Cleveland, are daily adding thereto. As illustrations of British parasitic species, it will suffice here to notice the occurrence of *Calicium turbinatum*, *Lecidea inspersa*, and *Acolium stigonellum*, on *Pertusaria communis*: *Scutula Wallrothii* and *Celidium fusco-purpureum* on *Peltigera canina*: *Celidium*

* 'Systema Lichenum Germaniæ. Die Flechten Deutschlands (insbesondere Schlesiens) mikroskopisch geprüft, kritisch gesichtet, charakteristisch beschrieben und systematisch geordnet von Dr. G. W. Koerber.' Breslau, 1856.

Stictarum on *Sticta pulmonaria* and *S. scrobiculata*: *Phacopsis varia* on *Parmelia parietina*: *Phacopsis vulpina* on *Cornicularia vulpina*: *Arthonia glaucomaria* on *Lecanora glaucoma*: *Verrucaria rimosicola* on *Lecidea rimosa*: *Lecidea vitellinaria* on *Lecanora vitellina*: and *Sphinctrina septata* on *Thelotrema lepadinum*. We doubt not that botanists have only to direct attention to parasitic lichens in order to discover many new and interesting species. There is a wide field open here for scientific research: we are but on the threshold of the inquiry. Körber most truly remarks (p. 216):

"Es öffnet sich hier ein ebenso für die Physiologie, wie für die systematik der Flechten überaus reiches Feld der Beobachtung, dessen Grenzen vor der Hand noch nicht abzusehen sind, und dessen fleissige Bearbeitung uns einst über die Verwandtschaft der Flechten mit gewissen Pilzordnungen genügendere Aufschlüsse geben wird, als bis jetzt gegeben werden konnten."

The presence of stylospores and the absence of a thallus tend to assimilate the genus closely to the Fungi. We are daily finding closer links between the great families of Lichens and Fungi; and the shades of distinction, the marks of differentiation, in the lower tribes of both are becoming less conspicuous. It were well, therefore, that the lower or more minute, and hitherto little-known lichens should be studied cotemporaneously by lichenologists and mycologists, or by botanists possessing an intimate knowledge of the structure and affinities of the Fungi as well as of those of the Lichens. Standing as they do on a debateable and ever-shifting border ground, their just claims in regard to their position in the scale of vegetation can only be decided by a species of scientific arbitration. Hitherto too many of the lower lichens have been claimed as fungi. Lichenologists are now making raids among the ranks of the latter, and there is a danger that, in their too eager search for deserters, or animated by a spirit of retaliation, they may seize plants which do not properly belong to them. Moreover, it is highly desirable that British microscopists should take up the subject of the minute anatomy of the lichens, and especially of their reproductive organs. With the exception of the elaborate works of Mr. Leighton of Shrewsbury, we have nothing to place in competition with the monographs of Tulasne, Montagne, De Notaris, Flotow, Nylander, Massalongo, and other Continental observers. And lastly, I gladly avail myself of the opportunity of illustrating, in a single small and comparatively unknown genus, the chief

forms of reproductive organs in lichens which have been hitherto discovered and described.

Tulasne describes the five following species of Abrothallus, viz.:

1. *A. Smithii.*
2. *A. Welwitzschii.*
3. *A. microspermus.*
4. *A. oxysporus.*
5. *A. inquinans.*

It appears to me that, probably from an examination of a limited number of specimens, Tulasne has created an unnecessary number of species, which I think admit satisfactorily of being reduced to two. The reasons which lead me to propose such a reduction will appear more fully in the subsequent analysis of the structure and character of the species, so far as I have been enabled to examine them in Scotch, Welsh, and English specimens. Meanwhile, I would state here that Tulasne does not appear to have made sufficient allowance for differences in minor characters produced by variations in habitat, when we consider that the Abrothalli grow on lichens so opposite in their habits as *Parmelia saxatilis, P. caperata, P. conspersa, P. olivacea, P. tiliacea, Sticta fuliginosa, Sticta sylvatica,* and *Cetraria glauca.* I cannot regard the characters on which he has founded the differentiation of the first three species above mentioned as sufficient or satisfactory. I shall, therefore, include them under the same species, to which I shall retain the name of the first—*A. Smithii.* But, while Tulasne's characters are insufficient to separate the lichens which he describes as *species,* they are, to a certain extent, characteristic of *varieties.* The more prominent of these characters, so far as they accord with my own observations, I propose to preserve under the varieties α, *ater,* β, *pulverulentus,* and δ, *microspermus,* of *A. Smithii.* The fourth species, *A. oxysporus,* appears a most natural one. The fifth species, *A. inquinans,* which Tulasne designates a "species recedens," I would discard as not properly pertaining to the genus under consideration. It appears more to belong to *Celidium* or an allied genus. It differs from the two species of Abrothallus hereafter to be described—1st, in its apothecia being superficial or epithalline, and not bursting through the cortical layer of the matrix; 2d, in these apothecia being minute and arranged in orbicular patches, the central ones confluent in deformed maculæ; 3d, in the form of the spores, which more resemble the oval stylospores of the other species; and 4th, in its occurring on a tartareous thallus, the sterile crust of a Bæomyces. In the description

of the amended characters of the genus Abrothallus, and of the species *A. Smithii* and *A. oxysporus*, I have retained the names originally bestowed on them by De Notaris and Tulasne, not because I prefer them as peculiarly appropriate; but because I am averse to increase the "confusion worse confounded" of lichenological nomenclature by altering old and conferring new names, where it is not absolutely necessary. A complex synonymy has too long been a stumbling block to the lichenological student. I cannot, however, omit to notice here the faultiness of the generic term originally proposed by De Notaris (*Abrothallus*, from ἀβρό, thin or delicate, in allusion to a supposed thin or delicate thallus), he having mistaken deformed portions of the thallus of *P. saxatilis* for the proper thallus of the parasite. Tulasne has proposed a name, which is less objectionable, viz., *Phymatopsis*, from φῦμα, a tuber, and ὄψις, like; but I prefer retaining the first for the reasons just stated.

The insertion here of the amended characters of the genus *Abrothallus*, and of the species *A. Smithii* and *A. oxysporus*, —so far as based on my own researches,—will facilitate the subsequent details of minute structure.

Körber arranges the genus Abrothallus in the sub-family Biatorineæ, of the natural order Lecideaceæ; and the structure of the apothecia appears to me to justify his classification. He only, however, describes the species *A. Smithii* and *A. microspermus*, the latter of which I shall show is to be regarded as only a variety of the former; and he removes the other species described by Tulasne out of the genus *Abrothallus*, from which they are distinguished by their very different spores. He does not appear to have had full opportunities of studying them; for he speaks of them as hitherto unobserved in Germany. Hence his decision is based on insufficient grounds.

Gen. *Abrothallus*, De Notaris emend.—Species athalline; parasitic on the thallus of various foliaceous lichens. *Apothecia* developed in medullary tissue of matrix; burst through, sometimes fissuring in a radiate manner, the cortical layer, which may form a raised border; finally seated on, or partially immersed in, the alien thallus; at first flattened or discoid, sometimes becoming pulviniform or globose; immarginate; circumference agglutinated to matrix or free; smooth or pulverulent; mostly black. *Hypothecium* brownish or greenish. *Thecæ* eight-spored, clavate, becoming obovate; amyloid reaction with iodine often inconspicuous or absent.

Paraphyses closely aggregated; thickened, deeply coloured, and cohering at their apices. *Spores* ovate-oblong and obtuse at ends, or ellipsoid and acute; two-locular—the loculi being unequal in size, and the larger one always looking towards the apex of the theca—or simple; of an olive-green or brownish colour, or pale; frequently containing two or more globular nuclei. *Spermogones* immersed, spherical, one-locular, opening by a point-like or stellate-fissured ostiole; envelope of a deep brown tint. *Sterigmata* simple, slender, irregular; generating from their apices only, linear, straight, slender *Spermatia*. *Pycnides* also immersed, spherical, one-locular, opening by a simple or stellate ostiole, generally larger and more conspicuous than the spermogones. *Sterigmata* short, simple, sometimes inconspicuous or absent; monospored, generating from their apices, the stylospores, which are pyriform or obovate, simple, pale, obtuse at ends, and contain an oily protoplasm or distinct oil globules.

Species I.—*A. Smithii*, Tul. emend. (including the *A. Smithii*, *A. Welwitzschii*, and *A. microspermus* of Tulasne, and the *A. Bertianus* and *A. Buellianus*, De Not. and Massol. Ricerch., 88. *Biatora Parmeliarum*, Fw., in litt. Smmf. Lapp., 176 [sub. Lecid.] *Endoc parasit.*, Ach., Syn. 100. Fw., L. E., 451). *Apothecia* epithalline, scattered, rarely confluent, prominent, pulviniform or globose, normally smooth and black, sometimes green-pruinose; circumference agglutinated or free; ultimately falling out and leaving distinct cyphelloid foveolæ, which have frequently raised and dark margins. *Hypothecium* olive-coloured. *Thecæ:* amyloid reaction with iodine feeble or none. *Spores* ovate-oblong (Körber describes them as soleæform or "schuhsohlenförning"), two-locular, upper segment broader and shorter than lower, olive-green or brownish; vary in size; loculi frequently containing one or two globular nuclei. *Spermogones* absent. *Pycnides* abundant.

α. Var. *ater*. Apothecia black and smooth. (*A. Smithii*, Tul. in part.)

β. Var. *pulverulentus*. Apothecia sparingly or copiously green-pulverulent. (*A. Smithii*, Tul. in part, and *A. Welwitzschii*, Tul. Leight. L. E. fasc. vi, No. 191.)

δ. Var. *microspermus*. Spores small and pale. (*A. microspermus*, Tul.)

Habitats.—I. On furfuraceous states of *Parmelia saxatilis;*

generally associated with *A. oxysporus*. In a large proportion of cases, varieties α and β occurred on the same specimen. Sometimes, however, var. α predominated or was found alone,—for example, on dry exposed walls in Highland districts, or on boulders on Highland mountains. At other times, var. β was the more abundant form, chiefly on damp and shady roadside walls, both in Lowland and Highland localities. The var. δ, in which, according to Tulasne, the spores are all small and pale, I have not met with.

A. On walls: in Highland districts, built chiefly of granite, gneiss, mica slate, and other primitive or metamorphic rocks; in Lowland districts, built chiefly of basalt, greenstone, porphyry, amygdaloid, or other members of the trap series, of new or old red sandstone, &c.

1. Craigie Hill, Perth; with pycnides. Trap, primitive and metamorphic rocks.
2. Birnam Hill, Dunkeld; with pycnides. Clay slate series, including hornblende and chlorite slates.
3. Craig-y-Barns, Dunkeld; with pycnides. Mica slate series.
4. Amulree road, Strathbraan, Dunkeld; with pycnides. Clay slate and mica slate.
5. Highland road between Blairgowrie and Percy; with pycnides. Gneiss.
6. Highland road between Percy and Spittal of Glenshee; with pycnides. Gneiss and quartz rock.
7. Glenshee, Glen Beg, and Glen Clunie, between Spittal of Glenshee and Braemar; *pycnides* more abundant than in any other station. Mica, hornblende, and chlorite slates; gneiss and quartz rock.
8. Road between Braemar and Corramulzie Linn; with pycnides. Gneiss.
9. Glen-tilt road, about Linn of Dee; with pycnides. Quartzose mica slate, and gneiss.
10. Deeside road, near Invercauld, Braemar. Gneiss.
11. Ben Lawers, Loch Tay; with pycnides. Mica slate.
12. Banks of Crinan Canal. Gneiss, mica and clay slates.
13. Road between Sligachan and Portree, Isle of Skye; with pycnides. Syenite, greenstone, compact felspar, amygdaloid and other trap rocks.
14. Great northern road, Uig, Skye; with pycnides. Trap rocks, chiefly amygdaloids, basalts, and greenstones.

15. Road between Dumfries and Caerlaverock; with pycnides. New red sandstone.*

B. On boulders, or rocks *in situ*, on Highland and Lowland hills: on the former, it is usually found at low elevations, that is, towards the base of the higher Highland mountains; on the latter, it occurs at all elevations.

1. Moors to the west of Braemar; with pycnides. Gneiss.
2. Craig-choinich, Braemar. Granite.
3. Mor-chone, Braemar. Granite.
4. Loch-na-gar, Braemar; with pycnides. Granite.
5. Glen Dee, Braemar. Granite.
6. Ben Nevis. Mica slate, gneiss, granite.
7. Moncrieffe Hill, Perth. Basalt, greenstone, amygdaloid, and other trap rocks.

C. On trees: the ash.

1. Road between Dumfries and Caerlaverock; with pycnides.

D. Special habitats unknown.

1. Wrekin Hill, Shropshire. (Leighton's 'Lich. Brit. exsicc.,' No. 46, fasc. 2.)
2. Barmouth, North Wales. (Rev. W. A. Leighton.)

II.—On *Sticta fuliginosa*.

1. Rocks, New Cut, Meadfort, Torquay, Devonshire. (Leight. 'Lich. Brit. exsicc.,' No. 191, fasc. 6, var. β. [sub nom. *A. Welwitzschii*, Mont.])

In addition to the habitats which I have given above, Tulasne mentions the occurrence of *A. Smithii* on *Parmelia olivacea*, *P. tiliacea*, and *P. omphalodes*, in France. I have never met with it on any of these species. I should doubt its occurrence on *P. omphalodes*; and suspect that a dark-coloured form of *P. saxatilis* has been mistaken therefor. Körber also gives *P. olivacea*, *P. tiliacea*, and *Cetraria glauca* as habitats for it in Germany. On the latter I have seen *A. oxysporus*, but not *A. Smithii*. Var. β, Tulasne's *A. Welwitzschii*, is stated by him to occur on *Sticta sylvatica*, on the Serra de Cintra Mountains, Portugal.

* The geologic age of this sandstone is disputed, some authorities regarding it as properly the old red, and anterior in date to the coal series.—*Vide* Nicol's 'Geology of Scotland,' p. 43.

Spec. II.—*A. oxysporus*, Tul. emend.—Apothecia not prominent, chiefly immersed, flattened or discoid, blackish-brown, generally crowded. *Thecæ:* amyloid reaction with iodine distinct. *Paraphyses:* tips light brown. *Spores* ellipsoid, acute at ends, colourless or pale yellow, normally containing two yellowish globular nuclei placed towards the opposite extremities of the spore. *Spermogones* somewhat rare. *Pycnides* absent.

Habitats.—I. On furfuraceous states of *Parmelia saxatilis;* generally associated with *A. Smithii* at most of the localities already mentioned.

A. On walls:

1. Craigie Hill, Perth; with spermogones.
2. Birnam Hill, } Dunkeld.
3. Craig-y-Barns, } Dunkeld.
4. Strathbraan, } Dunkeld.
5. Highland road between Percy and Spittal of Glenshee; with spermogones.
6. Glenshee, Glen Beg, and Glen Clunie, between Spittal of Glenshee and Braemar; with spermogones.
7. Road between Braemar and Corramulzie Linn; with spermogones.
8. Deeside road, near Invercauld, Braemar.
9. Banks of Crinan Canal.
10. Road between Sligachan and Portree, Skye.
11. Road, Uig, Skye.
12. Road between Dumfries and Caerlaverock.

B. On boulders, or rocks *in situ:*

1. Moors to west of Braemar.
2. Craig Choinich, } Braemar.
3. Mor-chone, } Braemar.
4. Glen Dee, } Braemar.
5. Ben Nevis; with spermogones.
6. Loch Coruisk and Glen Sligachan, Skye. Trap rocks, porphyry, syenite, amygdaloids, &c.
7. Moncrieffe Hill, Perth.

C. On trees: the alder.

1. Glen Nevis.

D. Special habitat unknown:

1. Barmouth, North Wales (Leighton); with spermogones.

II. On *Parmelia conspersa.*

1. Barmouth, North Wales (Leighton); with spermogones.

III. On *Cetraria glauca.*

1. Barmouth, North Wales (Leighton); with spermogones. Körber also speaks of it as abundant on *C. glauca* in Germany.

In the earliest state in which I have observed them, the deformations of the thallus of *P. saxatilis,* on which the Abrothalli grow, occur as minute, simple, orbicular squamules, smooth above, black-fibrillose below. If they are studded over with the young apothecia of *A. oxysporus,* they greatly resemble the scale-like thalli of some Endocarpons. They are very different in appearance from the laciniæ of *P. saxatilis,* which are sinuate-lacinulate, and the lacinulæ divaricate-angulose with retuse extremities. They are epithalline, seated upon the ordinary thallus of *P. saxatilis,* from which they appear perfectly distinct. Hence such squamules have the appearance of separate and parasitic vegetations. Occasionally I have seen the Abrothalli growing on the normal laciniæ of furfuraceous forms of *P. saxatilis,* or on laciniæ very slightly modified. In other cases, the anamorphoses, in the structure of their laciniæ, closely resemble the ordinary thallus of *P. saxatilis.* Occasionally a few scattered apothecia of *A. Smithii,* with its pycnides, occur on simple squamules; but this is comparatively rare. With age these squamules undergo great modifications, and it is generally at a somewhat later period of development that they become the sites of the Abrothalli. The first change consists in their becoming lobed and polyphyllous; in this condition they not unfrequently resemble the var. *complicatum* of *Endocarpon miniatum. A. oxysporus* often inhabits thalli of this kind. This condition is well marked in specimens of *A. oxysporus* from Glen Nevis. Sometimes the lobes or squamules preserve a concavity of surface; more generally they acquire a convexity from a tendency to evolution or curling out of their edges, which in some cases are much thickened. The surface is occasionally much corrugated or pitted, and scattered over with grayish soredia or warts, which frequently crown the ridges of the plicæ. I have also seen the squamules pruinose like the thallus of *Parmelia pulverulenta.* In some cases—as in *A. oxysporus,* from Loch Coruisk, Skye, and in *A. Smithii,* growing on the

ash on the roadside between Dumfries and Caerlaverock—I have found cubical or octohedral crystals more or less abundantly in the thallus, apparently consisting of the carbonate or oxalate of lime. I have frequently detected crystalline matters of various kinds in the thallus of other lichens.

The colour of the squamules varies greatly in different habitats and localities. Sometimes they possess a peculiar leaden hue; such squamules, whether simple or polyphyllous, are generally sterile, or they bear pycnides scattered sparingly towards the margins and unassociated with apothecia. In Highland districts especially, the thallus is sometimes of a rusty red or copper colour, depending apparently on the absorption of peroxide of iron. This species of coloration is frequent also in the ordinary thallus of *P. saxatilis*. At other times the squamules have a light brownish tint on the surface; but the medullary tissue, as exhibited in fissures of the cortical layer, or in the foveolæ left by the falling out of the apothecia of *A. Smithii*, possesses a brilliant saffron tint, resembling that of the under surface of *Solorina crocea*. In other cases, the colour approximates that of the thallus of *P. saxatilis*, on which the deformations occur.

The thalli on which *A. Smithii* is parasitic generally become globose, irregular, gnarled masses, from the evolution of the edges already alluded to, and from the development of successive and super-imposed crops of new lobes or squamules. This convexity increases; the base of adhesion becomes narrowed by continued curling; and the globular mass may at length be easily detached from the thallus of *P. saxatilis*, to which it bears little or no resemblance. The most globular or hypertrophic specimens I have met with have been sterile forms of a leaden hue or light grayish colour, apparently developments of the squamules on which the pycnides of *A. Smithii* frequently occur alone. A section shows such a mass to consist of a series of irregularly disposed layers of squamules or lobes, separated by alternate strata of a brownish granular matter, the débris of the rhizinæ or black fibrils of their under surface. I have never seen these masses free; but, from a consideration of their mode of growth, I have no doubt that they may be ultimately detached by the wind or other agencies, and, continuing to vegetate in the way I have described, may become regularly globular, all trace of the base of adhesion being obliterated. In a specimen of *A. oxysporus*, on *Cetraria glauca*, from Barmouth, North Wales, for which I am indebted to Mr. Leighton, the parasite grows on peculiar bullose dilatations of the extremities of the laciniæ, or of some more central portion of the thallus of the Cetraria.

These peculiar deformities appear to arise as pustules of the thallus, which gradually become distended and inflated, till they assume a bladder-like form. At the same time, their base sometimes becomes altered into a narrow peduncle, apparently by a process of contraction in the surrounding tissues, and a pyriform or globular bulla is produced. By continued contraction of the base of adhesion the mass may become free; the peduncle may disappear, and a regularly globular form be produced. In such a state these bladder-like bodies of extreme lightness would readily be carried great distances by the wind, and might accumulate in particular localities. This is doubtless Schærer's var. *bullata* of *C. glauca*, of which he says ('Enum. Crit. Lich. Europ.,' p. 13, 1850): "Thalli lobulis extremis in capitula inflata transformatis." These pustules or bladder-like dilatations must be regarded as morbid conditions of the thallus, produced by the growth of the parasites. They are analogous to the blisters caused on the leaves, and excrescences from the bark or stems of various of the higher plants produced by the attacks of insects. But it does not appear to me that the anamorphoses of the thallus of *P. saxatilis*, on which the Abrothalli grow, can be placed in the same category. They are neither dilatations of, nor excrescences from, the parent thallus, but distinct and superimposed, sometimes easily detachable, growths. I think, therefore, that Körber has taken an erroneous and limited view of the subject when he observes: "Die stellen des Imbricarien- und Cetrarien-lagers, welche von diesem Parasiten überwüchert werden, bilden eigenthümliche bauschige Anschwellungen, welche das durch den Schmarotzer bedingte Kränkeln der Mutterpflanze deutlich verrathen, früher jedoch als eigne Lager dem Parasiten fälschlich zugeschrieben wurden (p. 216); (speaking of *P. saxatilis*, p. 73): auf den eignen Lager eigenthümliche kleinlappige, krankhaft aussehende und mit dem parasitischen Abrothallus Bertianus besetzte Polster bildend; (and of *P. caperata*): des Lager der Imbricaria caperata wird von diesem Parasiten (*A. microspermus*) weniger krankhaft verändert" (p. 216.) His error probably arises from his not having carefully studied the origin and development of these anamorphoses in any considerable number of specimens. In the Braemar district I have not unfrequently met with globular dilatations or excrescences of the thallus of *Lecanora tartarea*, *L. parella*, *L. ventosa*, and other lichens, unassociated with any parasitic growths. Nor have I ever seen such dilatations or excrescences in *P. saxatilis*, on whose normal laciniæ, as I have already stated, the Abrothalli sometimes occur.

The deformations of the thallus of *Parmelia conspersa*, on which *A. oxysporus* grows, as examined in specimens from Barmouth, communicated by Mr. Leighton, more resemble those of *C. glauca* than those of *P. saxatilis*. In Welsh specimens of *A. Smithii* and *A. oxysporus*, growing on furfuraceous forms of *P. saxatilis*, the portions of thallus on which the parasites occur have more the character of the ordinary laciniæ of *P. saxatilis* than in Scotch specimens. The thallus of *P. saxatilis* in these specimens is whitish, friable, and mealy, compared with Scotch ones, which are tough and coriaceous. This difference is probably to be accounted for by differences in the geological character of the habitat.

In addition to the other irregularities of structure or appearance already alluded to, I have occasionally observed, particularly in Highland specimens, the cortical layer of the deformed thalli partially or wholly eroded, apparently by insects, the subjacent white or medullary tissue being thereby exposed. This erosion sometimes appeared like a cross section of a number of plicæ on the same squamule, or of a series of superimposed squamules or lobes. It occurs sometimes in similar localities in the ordinary thallus of *P. saxatilis*, as well as on its anamorphoses. Frequently the medullary tissue exposed is of a brilliant saffron-yellow. I have frequently noticed on damp walls a similar condition of *Parmelia parietina*, giving the thallus and apothecia a white-variegated appearance.

The origin and mode of growth of the globular deformations of the thallus of *P. saxatilis* and *Cetraria glauca* above described, appear to me to throw a new light on the nature of the var. *concentrica* of *P. saxatilis* (Leight. 'Lich. Brit. exsicc.,' No. 232, fasc. 8, 1856), lately found by Sir W. C. Trevelyan, rolling freely before the wind on the exposed sheep-walks or chalk downs of Dorsetshire, and particularly on Melbury Hill, near Shaftesbury.* The characteristics of this curious lichen are, its erratic nature, its globular form, and its want of adhesion to any base of support. Its external appearance, as well as its characters on section, are very similar to those of the lead-coloured or grayish, globose anamorphoses of the thallus of *P. saxatilis* before referred to. Specimens of the latter, if detached and rolled about on the surface of the ground in a similar way, would undoubtedly acquire a similarly globose form. This erratic form of *P.*

* Proceedings of the Botan. Society of Edinburgh, in 'Scottish Gardener,' March, 1856, p. 100; and Notes by Rev. M. J. Berkeley, in 'Gardener's Chronicle,' Feb. 9th, 1856, p. 84, and March 15th, 1856, p. 172.

saxatilis appears to grow after detachment from its base of support; and its peculiar shape seems due both to curling up of the margins of the lobes, and to repeated and superimposed epithalline growths from and upon the original nucleus. The lobes or laciniæ are smooth, shining, and of a light gray tint. A few grayish soredia are occasionally scattered over the surface; but I have not noticed, in specimens kindly forwarded to me by Sir W. C. Trevelyan, nor in the specimen contained in Leighton's 'Lich. Brit. exsicc.,' any of the reproductive organs of the Abrothalli. I do not, however, regard the absence of the latter as at all a disproof of the lichen being developed in the way I have hinted; for I have already stated that it most closely resembles sterile forms of the deformations of *P. saxatilis* above described. It is perfectly possible, moreover, that laciniæ or squamules bearing the pycnides, spermogones, or even apothecia of the Abrothalli, have been covered over and concealed by subsequent epithalline growths. "There is no good reason why they should not fructify," says Berkeley in the 'Gardener's Chronicle,' March 15th, 1856, p. 172; but if the view just propounded of the nature and origin of these erratic masses be correct, we should never expect to find on them the normal apothecia of *P. saxatilis*, though we might have good grounds for anticipating the occasional occurrence of the pycnides or spermogones of the Abrothalli. The theories hitherto started to account for their peculiar form do not appear to me to be satisfactory, viz., that they have been formed round the droppings of sheep or rabbits, as nuclei, or that they have grown on the twigs of trees, whence they have been subsequently detached. Berkeley and Babington regard the erratic lichen in question as a form of *Parmelia cæsia*, or one of the "short-lobed forms of the *Parmelia stellaris* group;" but Sir W. Hooker, Sir W. C. Trevelyan, and Leighton consider it a form of *P. saxatilis*, and in this opinion, though I had at first some difficulty in deciding, I entirely concur. Further, there is a close resemblance between this erratic species and various Lecanoras of a globular form, and showing no point of adhesion, which have at various times been described by travellers as suddenly covering, like manna, large tracts of country in Asia, and as being eaten by cattle and by nomadic tribes of natives.* Such lichens are the *Lecanora esculenta* and *affinis* of Tartary and Persia. I have not been fortunate enough to see specimens of these interesting lichens; but I think it ex-

* *Vide* the author's 'Popular History of British Lichens' (Reeve, London, 1856), pp. 211 and 228.

tremely probable that they are not independent species, but merely malformations of some more familiar lichens. This idea, Berkeley mentions, has also occurred to Sir W. Hooker.

I. *A. Smithii.*—Of 71 sheets, containing about 250 specimens of *A. Smithii* and *A. oxysporus*, generally intermixed, the former species occurred in 54 cases, or about 76 per cent.; while the latter was found in 42 cases, or about 59 per cent. Of the two species, therefore, *A. Smithii* is the more abundant, though the preponderance is not very greatly in its favour. The young apothecia appear first to occur as spherical, blackish warts in the medullary tissue of the matrix (by which name I mean to designate the deformed portions of the thallus of *P. saxatilis*, and other lichens, on which the parasite occurs). Increasing gradually in size and colour, such an apothecial wart pushes its way to the surface, and perforates the cortical layer, either by a slow process, whereby the latter is thinned without fissuring, or rapidly, whereby more or less extensive radiate-fissuring is produced. In the former case the cortical border of the nascent apothecium is comparatively entire; in the latter it is irregularly broken by the stellate fissures, which, like the apothecium itself, generally appear black. After its evolution through the cortical layer, the apothecium swells, becoming globose; and its margins gradually overlap the cortical border. To the latter the margins are at first more or less closely appressed: sometimes they become agglutinated; at other times they remain, or become, with age, free. The latter condition seems to be assisted, if not produced, by a gradual contraction, as the apothecium becomes mature and old, of its base,—the hypothecial tissue. This process goes on till the apothecium falls away, leaving a saucer-shaped cavity or foveola, closely resembling, at a later stage of its development, or rather retrogression, the cyphellæ of the *Sticta*. With age, such cavities or pits become more urceolate, and their edges better defined. The latter are frequently distinctly raised and dark coloured; while the cavity of the foveolæ may remain whitish, reddish, saffron-coloured, or it gradually assumes a brownish tint. These foveolæ are peculiar to *A. Smithii*, and are frequently seen on the old thallus, especially in Highland districts. I have never noticed them in *A. oxysporus*. When young and emergent, especially if deplanate, the apothecia of *A. Smithii* resemble somewhat the nascent apothecia of *A. oxysporus*; but a microscopic examination will at once detect the difference. In specimens of *A. Smithii* from the neighbour

hood of Portree, Skye, I found the young apothecia indistinguishable, by the naked eye, from those of *A. oxysporus*. These apothecia were flattened and black, with rough or pulverulent surface, agglutinated borders, and surrounding radiate-fissuring of the cortical layer of the thallus. The adhesion of the margins of the apothecia to the cortical layer is sometimes so intimate, that the base appears gradually shaded off or passing into the matrix, like the perithecia of *Verrucaria epidermidis*. This, however, is rare. I have seen it only in a few hill specimens. The gradual contraction of the hypothecium, or base of adhesion, renders the enucleation of the old apothecia easy.

Of the mode of evolution of the apothecia in his three species, Tulasne says that, in *A. Smithii*, "E matrice lente ac tali modo emergunt ut ejus cutem vix effringere illique e contrario primum marginibus adglutinari videantur;" in *A. Welwitzschii*, "Matricis cuticulam ita in erumpendo effringant ut istius frustula erecta hymenii discum quasi vallo ambiant;" while, in *A. microspermus*, "E matrice pedetentim emergit, cujus cuticulam fractam non sublevat et isti e contrario toto ambitu adnasci s. conglutinari diu videtur." The relations of the apothecial margins to the surrounding cortical tissue do not appear to me to furnish good characters for differentiation. I think I have seen all the appearances which Tulasne describes in different specimens of the varieties which I have designated *ater* and *pulverulentus*, even from the same locality. The *A. Welwitzschii* of Leighton's 'Lich. Brit. exsicc.' does not differ, either in external characters or in internal structure, from green-pulverulent forms of *A. Smithii* found by myself abundantly on Craigie Hill and elsewhere; but it rises directly from the ordinary thallus of *Sticta fuliginosa*. The only specimen which I have had an opportunity of examining has only two apothecia. One of these is flattened, not very prominent, and appears agglutinated at the margins; the other, on being moistened, becomes globose and substipitate, and has distinctly no raised margin of cortical tissue. Neither does the degree of flattening or convexity of the apothecia afford a good means of differential diagnosis; it differs widely in specimens from various localities. The apothecia of *A. Smithii*, says Tulasne, are "discoidea, pulviniformia, tandemque maxime convexa;" those of *A. Welwitzschii* are "magis vulgo deplanata;" while *A. microspermus*, "attamen puncta atra latiora et depressiora vulgo sistit." I have frequently met with the apothecia both of varieties α and β flattened, sometimes tuberculiform and even

confluent. In the latter case only two or three apothecia were usually in apposition; their margins, though modified by pressure, were distinct, and their surface was flattened. So flattened, semi-immersed, and inconspicuous have the apothecia of *A. Smithii* sometimes been in Highland specimens, that I have mistaken them, by the naked eye, for those of *A. oxysporus*. I have also seen them, in the old state, immediately prior to their falling out, when their base of adhesion is constricted to a very narrow peduncle, capitate or substipitate. The apothecia of var. α are sometimes exasperate or slightly black-pulverulent; or, still more rarely, in Highland specimens, they have appeared to be faintly marked by striæ or gyræ, like those of some of the Umbilicarias. Another basis whereon Tulasne founds his specific distinctions, is the presence or absence, as well as the degree, of green-pulverulence, of the apothecia. According to that observer, the apothecia of *A. Smithii* are "sparsim virenti-pulverulentis aut glabris;" those of *A. Welwitzschii* are "pulvere chlorino velatis;" while in regard to those of *A. microspermus*, he remarks, "nec pulverem virentem ei inspersum vidi." The green-pulverulence, I believe, is merely an illustration of the pulverulent or pruinose condition of the apothecia, so common among lichens, and which is one form of sorediiferous degeneration. The green powder, which varies greatly in degree, consists chiefly of gonidia; as do also the globose, greenish, powdery warts, resembling, in general appearance, the apothecia, in var. β *pulverulentus*, which I have met with occasionally on the same thallus,—as in specimens from Craig-y-Barns, Dunkeld. These warts are generally less regular in form than the apothecia in question, from which, however, they are sometimes indistinguishable without the microscope. I have repeatedly seen black and green-pulverulent apothecia occurring on the same thallus: but in certain localities the former predominate; in others the latter. On Ben Lawers I found only black apothecia; on Craigie Hill, Perth, the green-pulverulent ones are abundant. The latter I have noticed chiefly in damp, shady places—precisely the situations favorable to sorediiferous degeneration.

The development of the thecæ and spores resembles what obtains in the majority of other lichens. The theca arises from the hypothecium as a small, colourless, spherical cell, which gradually becomes elongated upwards so as to acquire a clavate form. It contains at first a colourless, minutely granular or amorphous protoplasm, which fills its whole cavity. Gradually this is limited by the spore-sac, which is

seen, especially under the use of iodine and other reagents, to be distinct from the thecal wall, more particularly at the apex, where a considerable space sometimes intervenes between them. The protoplasm slowly acquires a pale yellowish tint, and become smore granular; bye and bye it exhibits division into oval masses, which are the future spores. Two button-like nuclei of a pale lemon-yellow colour soon appear, and occupy those parts of the spore which are subsequently divided by a central septum into the two loculi. Meanwhile the theca has increased in breadth towards the apex, and has assumed more of an obovate form; the spore-sac and thecal wall have been distended by the gradual development of the spores. At this stage the theca is a very pretty object under the microscope. The protoplasm, as yet faintly coloured and finely granular, is studded over with the button-like nuclei of the spores, which are more prominent than their walls or septa. A similar appearance may be readily observed in the young thecæ of *Parmelia parietina* and some other lichens. This button-studded appearance, however, is much better marked in *A. oxysporus*, in which the spores remain colourless or very pale, and the lemon-coloured nuclei consequently very prominent; besides the spores of *A. Smithii* do not always possess or exhibit the nuclei in question. The septum of the spores now becomes apparent; their walls are better defined; their colour has passed through various shades of yellow and green till it has become an olive-green; and the nuclei or secondary cellules remain or disappear. The distension of the theca progresses in proportion to the maturescence of the spores, the inferior extremity or peduncle tapering suddenly or gradually from the upper, sometimes almost spherical, portion. Finally, the spore-sac and theca are ruptured at the apex, and, immediately after the emission of their contents, disappear. The spores escape, and after they are free they expand in dimensions, acquire more of a brown colour, and have a better-defined wall and septum; the loculi are separated by a distinct constriction, and they exhibit an inequality of size, one being considerably broader than the other. Tulasne speaks of the thecæ in the genus Abrothallus being clavate; but this appears to me to be true of them only in their young state. I have repeatedly tested the amyloid nature of the thecæ by solutions of iodine, diluted and strong, but with negative results. In one or two cases only did I discover a faint bluish tint developed; in the majority the iodine merely communicated its own tinge or produced no effect. This result accords essentially with the

observations of Tulasne, who says of the thecæ of *A. Smithii*, "In iode soluto immersi nonnisi apice et dilute, quandoque etiam vix conspicue cærulescunt:" of those of *A. Welwitzschii*, "nec nisi dilutissime in iode soluto cærulescunt:" while those of *A. microspermus* consist of a "membrana crassa qua fabricantur in iode soluto tantum sordide flavescit eodem scil. modo ac sporæ."

In all the varieties which I have examined the spores had essentially the same characters. As measured by an eye-piece micrometer, made by Bryson of Edinburgh, they generally varied in length from $\frac{1}{1100}$ to $\frac{1}{1500}$ inch, and in breadth from $\frac{1}{2500}$ to $\frac{1}{3500}$: sometimes, however, they were larger; at other times smaller. In general appearance they resembled the spores of *Physcia ciliaris*, and some of the *Calicia*; and they appeared intermediate in size between them. Körber describes them as shoe-sole-shaped ("schuhsohlenförmig"), which, though rather an awkward designation, conveys a very true idea of their appearance. In many cases there was little distinction in size between the loculi: these were chiefly young spores. The spores were generally olive-green—seldom of a deep brown. The latter tint I have observed only in a few instances—as in specimens of var. α from Ben Lawers, the *A. Welwitzschii* of Leighton's 'Lich. Brit. exsicc.' &c., The spores of the Ben Lawers specimens were dark umber-coloured, and broader than any I have as yet seen: they had somewhat the appearance of a figure of 8, and closely resembled on a small scale the spores of *P. ciliaris*. Tulasne describes the spores of *A. Smithii* as "atræ v. spisse fuscæ;" those of *A. Welwitzschii* as "saturate fuscæ;" and those of *A. microspermus* as "vulgo pallidæ." I would suggest that the dark colour of the spores observed by him may be due to his having examined chiefly herbarium specimens. Iodine seems to have no reaction on the spores of *A. Smithii* or *A. oxysporus*. Tulasne allows a similarity in the characters of the spores between his *A. Smithii* and *A. Welwitzschii*; for he says of the latter, "ab illis ejusdem lichenis forma crassitudineque non differunt." Of *A. microspermus*, he remarks: "Speciei criterium in seminum utriusque generis exiguitate præsertim ponitur." The paleness and minute size of the spores here constitute a peculiarity; but they do not appear sufficient to form specific differential characters. Körber remarks: "Die Unterschiede von der vorigen Art (*A. Smithii*) sind nur gering, so dass sie vielleicht besser als Varietät zu dieser zu bringen ist" (p. 216). Tulasne gives, as the habitat of this species, *Parmelia caperata*. Körber says *P. caperata* with *A. micro-*

spermus parasitic on it is rare in Germany. I have had no opportunity of examining it. When its minute anatomy is fully investigated, good grounds may appear for retaining it as an independent species; meanwhile I cannot give it a higher place than that of a variety. Tulasne himself confesses, "Abrothallum Smithii et hunc præsertim qui in Parmelia tiliacea parasitatur summopere æmulatur."

In *A. Smithii* "Guttula oleosa in utroque cujusvis sporæ maturæ locello includitur," says Tulasne. In certain cases I have noticed secondary cellules or nuclei in the spores: in others I have not. They were distinct in specimens from Craig-y-Barns, Dunkeld: they were absent in *A. Welwitzschii*, from Torquay, and in *A. Smithii*, from the Wrekin, Shropshire (both contained in Leighton's 'Lich. Brit. exsicc.') Frequently one comparatively large cellule occurred in each loculus, lying usually towards the outer extremity thereof: sometimes there were two in each, their size being smaller; or one of the loculi contained a large nucleus, while the other contained two smaller ones. In apothecia from certain localities, or on particular thalli, this character of the spores was pretty constant; but the nuclei in question were as frequently, in other specimens, absent. I could not satisfy myself as to the oily nature of these bodies; they appeared to me to be too regular in their form, too uniform in their position, too constant in certain specimens, while they were altogether absent in others, to be mere "guttula oleosa." The use of ether, aqua potassæ, aqua ammoniæ, and other reagents, has satisfied me of the oily nature of the globules and protoplasm of the stylospores, and also of a portion, at least, of the protoplasm of the spores of *A. oxysporus*. But I have been unable to convince myself that the nuclei of the latter, or of the spores of *A. Smithii*, are solely or partially oily. Another difficulty frequently occurs in regard to determining the nature of the nuclei of certain spores. The characteristic yellow nuclei of the spores of *Parmelia parietina*, for example, have been variously regarded as an external coating of the ends of the spore, as secondary cellules occupying the opposite extremities of the interior of a cell, having thin walls, or as vacuoles hollowed in the material of a thick-walled or solid spore, and full of an oily or other protoplasm. It seems probable that spores and nuclei, possessing these varied characters, really do exist, though, in particular instances, it is difficult to decide to which of the classes above mentioned to refer them. In the spores of the Abrothalli the nuclei—be they cellules or globules—appear to occupy the interior

of a free cavity. On the same apothecia I have sometimes found the spores of both species of Abrothallus, as well as stylospores; and, on the thallus, the spores of various Lecideas and other lichens may also be met with. This illustrates the dissemination of the spores of lichens by the winds, rains, and other agencies.

So far as my observations enable me to decide, this species possesses no spermogones of the ordinary type—that is, of the structure usual in those of most lichens. I shall presently show that I am inclined to regard the pycnides as another or extraordinary type of spermogones,—in certain exceptional cases taking their place and fulfilling their functions. *A. Smithii* and *A. oxysporus* are frequently so intimately associated that the one may appear to possess spermogones and the other pycnides. In a few cases, I have seen spermogones intermixed with, and apparently belonging to, *A. Smithii;* and pycnides scattered among, as if pertaining to, a young state of *A. oxysporus;* but in the former case they really belonged to *A. oxysporus,* and in the latter to *A. Smithii,* the apothecia of which were also interspersed.

Of fifty-four sheets of specimens of *A. Smithii* (generally associated with *A. oxysporus,* and growing on furfuraceous states of *P. saxatilis*), I found *pycnides* present in thirty-four cases, or about 63 per cent.; while in forty-two sheets of *A. oxysporus* (similarly growing, and with which *A. Smithii* was associated), *Spermogones* occurred only in five instances, or about 12 per cent. The pycnides were therefore upwards of five times more frequent in *A. Smithii,* than the spermogones in *A. oxysporus.* Hence the normal, or usual, type of spermogones is comparatively rare in the genus Abrothallus; while the pycnidian, or exceptional, type is somewhat common. This is one of the characteristic features of the genus. In twenty-seven of the thirty-four cases, in which pycnides occurred, they were associated with the apothecia of *A. Smithii;* in four cases they were found alone, chiefly on the bluish or lead-coloured squamules already described; and in three instances they were intermixed with young apothecia of *A. oxysporus,* to which species they appeared (but erroneously) to belong. In site and external appearances, the *pycnides* closely resemble the spermogones of *A. oxysporus,* hereafter to be described; and are extremely apt to be mistaken therefor or confounded therewith. Like the latter, they occur as minute, black points, scattered generally over the surface, or only towards the periphery, of the squamules or lobes. Each point or spot is perforated by a simple or stellate pore, whose edges may be flattened, raised,

or occasionally depressed. This ostiole is, however, generally larger and more prominent than that of the spermogones, and its edges more frequently swollen and raised. Sometimes—as in specimens of *A. Smithii* from Glen Shee and Glen Beg—the pycnides are superficial, and prominent, forming rough, tuberculated, black warts, seated on the surface of the thallus, each pierced by a distinct pore. The body of the pycnidis is immersed, spherical, and enclosed in a brown cellular tissue. When moistened, the pycnides appear as brown translucent spots, precisely like the spermogones. Tulasne says that the pycnides of *A. Smithii* are "interdum copiosissimæ, imo apotheciis multo frequentiores," especially when they occur on *Parmelia tiliacea;* he also describes those of *A. microspermus* as abundant; but of *A. Welwitzschii,* he remarks, "Pycnides desiderantur." I have found the pycnides indiscriminately associated with varieties α and β, and am convinced that the description of the pycnides of his species *A. Smithii* applies equally to those of his *A. Welwitzschii.* I have never, however, noticed pycnides so abundantly distributed as Tulasne would seem to imply. I have seen an intermixture of spermogones with young apothecia in *A. oxysporus,* associated on the same squamule with *A. Smithii,* "interdum copiosissimæ;" and it appears to me possible, from the great resemblance, that Tulasne may have hurriedly overlooked the distinction between them, more particularly as he speaks of the "spermogoniæ ignotæ" of the genus Abrothallus. I have most frequently found the best specimens of pycnides scattered, to the number of four or six, near the margin of sterile squamules, which had a leaden or grayish hue, and were thickened, corrugated, and warted. While the other characters are similar, the pycnides differ remarkably from the spermogones in containing *stylospores,* instead of spermatia. These are cellular bodies, having much the appearance of certain spores, about $\frac{1}{1500}$ to $\frac{1}{2300}$ inch long, by $\frac{1}{2300}$ to $\frac{1}{3000}$ broad. They are normally pyriform or obovate; but they are sometimes spherical, oval, oblong, navicular, fusiform, or present irregular bulgings. These abnormalities of form generally occur in Highland specimens. Viewed in different lights, they may be colourless or of a pale yellow tinge; sometimes the contained globules were pale yellow; at other times the whole stylospore was of a distinct yellow. In the latter case, in Highland specimens, the stylospores were generally small and shrivelled. With regard to their contents, Tulasne remarks, "Nunc protoplasma subliquidum fereque homogeneum, nunc guttulas oleosas 2—3 fovent,"

in *A. Smithii*; while in *A. microspermus*, they are "materieque oleosa et homogenea fœtas." All these conditions frequently exist in the stylospores of the same variety. Very frequently a single large globule occupied the cavity of the stylospore, extending across its whole breadth, but leaving interspaces at the extremities; or a large globule filled the broader end, while the opposite contained two or more smaller globules. Sometimes the stylospore contained a mass of small globules and granules of different size; at other times the protoplasm was finely granular or grumous; or it was perfectly homogeneous and transparent. This appeared to be the highest state of development of the stylospore. The application of ether, aqua potassæ, and aqua ammoniæ satisfied me that in all these cases the protoplasm was oily. The oil globules could readily be squeezed from the stylospores, and made to coalesce into larger globules; and the stylospores were almost invariably associated—sometimes to a marked extent—with free, floating oil globules. Under the reagents these free oil globules were greatly increased in number and size, and the globules contained in the stylospores could be seen gradually being dissolved or broken up into a homogeneous fluid. These globules, like other oil globules, refracted light powerfully, and were very prominent objects in the interior of the stylospores. Their numbers and size differed greatly in specimens from various localities. They were very large and numerous in Ben Lawers specimens, in which the stylospores were associated with a large quantity of free oil globules. A similarly large intermixture of oil globules, especially in the young state of the stylospores, was also observed in specimens from Glen Shee, the vicinity of Dumfries, and other localities. Some of the stylospores, in specimens from Ben Lawers, bore a resemblance to certain cellular spores, especially when elongated and containing two or more large globular nuclei. Here also there was considerable deformity of shape; some of the stylospores, which were among the largest I have seen, were almost spherical in form, and might have been mistaken for empty gonidia. This was not unfrequently the case also in other specimens. I have occasionally—as in specimens of *A. Smithii* from Glen Shee—seen the stylospores, from their shape and the arrangement of the contained globules, resembling certain states of the spores of *A. oxysporus*. Of the colour of the stylospores Tulasne says, "Singulatim spectata dilute flavida diceres;" while "horumce corpusculorum congeries in pycnidis sinu albescit copiosumque admittit aerem." He remarks further,

"Iode protoplasma fucatur, membrana autem utriculi vix mutatur." I did not find iodine produce any change further than communicating its own tinge. Like the spermatia, the stylospores are borne on a series of sterigmata, closely crowded together, and arranged in relation to the walls and cavity of the pycnidis as the spermatial sterigmata are to those of the spermogone. But the filaments generating the stylospores are uniformly simple and one-spored—the stylospore invariably being thrown off from the apex, and never from the sides. These filaments vary greatly in length; generally they are very short or inconspicuous; sometimes they appear to be absent. There is considerable variety also in thickness; being sometimes thick and short, at other times long, slender, and thin. In both cases they are usually very delicate. Sometimes they become shrivelled, and are retained, as caudate appendages, by the stylospores; this I frequently observed in the small yellow stylospores in Highland specimens. Each sterigma would appear to generate—as do also the spermatial sterigmata—a continuous series of stylospores, which in this case are thrown off as terminal cells or buds. The sterigmata of *A. Smithii*, Tulasne describes as "brevissimis stipatissis quandoque vix conspicuis crassis ac monosporis;" while, in *A. microspermus*, they are inconspicuous and but rarely "linearibus et longiusculis." The stylospore first appears as the rounded, bulging, or obovate extremity of a short, simple filament, which resembles, except in length, the paraphysis of a lichen. The end of this filament is full of a finely granular matter, which accumulates especially in the bulging portion; the latter is gradually separated by a septum. The terminal cell becomes broader towards its free end, and narrower towards its insertion upon the sterigma, until, at length, it is thrown off as the stylospore. The latter appears to attain its full size only after it is free; it expands in all its dimensions and acquires a pyriform shape. The granular protoplasm now becomes more distinct and more coarse; there is a gradual fusion of the smaller granules into globules, and these into larger globules, until the cavity of the stylospore is occupied by one or more large globules as I have already described. Finally these appear to deliquesce into a homogeneous, colourless, oily fluid, which gives rise to the colourless pyriform stylospore with apparent double contour. I have seen nothing like germination in the stylospores.

Stylospores have been hitherto found only in another minute parasitic genus—also described recently by Tulasne in his admirable memoir on the organography and physiology of the

lichens—*Scutula*. Their relation to the function of reproduction has yet to be determined. In certain respects they bear an analogy to the spermatia; in certain other respects to true spores. They are generated in conceptacles closely resembling, in site and external form, the spermogones; they also appear to precede the spores in order of development, and to be rather cotemporaneous with the spermatia; they are moreover, extra-thecal or extra-cellular, and are thrown off from the apices of peculiar filaments or sterigmata. On the other hand their size and form, and the nature of their contents, approximate them more to the character of true spores. There is a remarkable resemblance, however, between the stylospores and the pyriform or obovate bodies described as the spermatia of the Peltigeræ by Tulasne ('Mém.,' p. 200). The section of a spermogone of Peltigera precisely resembles, in the form and arrangement of its sterigmata and spermatia, the pycnidis of Abrothallus. A careful investigation will demonstrate that there is a regular gradation, in form and size, between the ordinary, straight, rod-shaped, minute spermatia of *Parmelia parietina, P. physodes,* or *Physcia ciliaris;* the ovoid spermatia of *Lichina confinis* and *L. pygmæa,* or of *Urceolaria calcarea* and *U. scruposa;* and the pyriform, comparatively large spermatia of *Peltigera canina.* From the anatomy of the genus Abrothallus,—which alone, however, is not sufficient to decide a question of such importance,—I am strongly inclined to regard the pycnides as merely an unusual form of spermogones, and hence undeserving of a separate designation and consideration. In *A. Smithii,* I have already stated I have never observed spermogones; and in *A. oxysporus* I have not met with pycnides. But the pycnides appear to bear precisely the same relation —in regard to site, predevelopment to the apothecia, &c.,— to the former, that the spermogones do to the latter. They are, therefore, probably endowed with similar functions, and act as substitutes for each other. Körber also regards the pycnides as the analogues of spermogones, for he says: "Ich halte dieselben für Analoga der Spermogonien, die, in der gewöhnlichen Form, bei Abrothallus zu fehlen scheinen, wobei freilich die bedeutendere Grösse der Stylosporen vor derder spermatien der übrigen Flechten sehr auffällig ist" (p. 215). Prior to the elaborate researches of Tulasne and other careful observers, the pycnides would undoubtedly have been regarded as the reproductive organs of some parasitic fungus. But we now know that some of the more minute fungi possess so many as four or five different kinds of reproductive bodies; and from the close affinity between the

lower tribes of fungi and lichens, there is good ground for believing that a similar diversity may occur also in the latter. Tulasne, who is no less eminent as a mycologist than as a lichenologist, regards the pycnides, which I have described, as properly pertaining to the genus Abrothallus; and Berkeley, than whom there is no more competent authority in this country, holds a similar opinion. In a recent correspondence with the latter distinguished botanist, he informs me that he is acquainted with one fungus—*Erysiphe* (*Ascomycetes*, subord. *Perisporiacei* of Lindley's 'Veget. Kingdom,' 3d. ed., 1853, p. 43)—which has no less than five different forms of reproductive bodies or organs, none of which can be looked upon as spermatia according to Tulasne's views; that many species of *Diplodia, Sphæropsis, Phoma*, &c., belong to *Sphæria, Tympanis, Cœnangium*, &c.; and that, prior to the recent discoveries on the reproduction of lichens, the pycnidis of the Abrothallus would have been designated a *Phoma*. The fact that the lower fungi and lichens may possess several very different reproductive corpuscles must greatly modify our future views of classification and nomenclature. "So convinced am I," says Berkeley, "of the near relation of lichens to fungi that, in the portion of my introduction to 'Cryptogamic Botany' which is printed, I make one division, *Mycetales*, to include *Fungales* and *Lichenales*" (*in lit.*)

I have occasionally noticed in the tissues forming or surrounding the walls of the pycnides, peculiar tubes, presenting, at irregular intervals, bulgings, which ultimately, by elongation and expansion, become dilated into obovate cells, destined to be thrown off like buds or gemmæ. In these lateral dilatations the granular protoplasm of the parent tubes appeared to accumulate, a septum was gradually developed, and the gemmule fell off at the point of division. These tubes generated large numbers of such cellular bodies, which increased in dimensions after their separation, and frequently bore a close resemblance to the stylospores, except that they were generally less regularly pyriform. Similar structures I have also noticed in the tissues of other lichens; but I have not yet directed special attention to their nature, and can, therefore, throw no light on the part which they play (if any) in the function of reproduction. The spermatial sterigmata in *A. oxysporus* appear sometimes to be developed laterally from tubes in a similar way. I have also observed in the tissues of various lichens, a tendency in certain filaments to develop lateral and terminal cells, of a round or obovate form, varying greatly in size, and generally

more or less granular internally. Similar appearances are figured in the elaborate but highly speculative memoir of Bayrhoffer.* I mention these crude observations suggestively here, not only from a wish to show that the reproduction of the lichens is even yet imperfectly understood, and that the subject of these accessory or secondary reproductive corpuscles will amply repay elaborate research, but because I am desirous of entering my protest against exceptions taken by Tulasne to certain observations made by Berkeley and Broome, Dr. J. D. Hooker and Babington, in this country. From some, apparently casual, observations of these botanists, it would appear that the paraphyses may sometimes assume the function of sterigmata, generating from their apices spheroid corpuscles, or may themselves be transformed into reproductive bodies. Tulasne throws a distinct doubt on the accuracy of the observations in question ('Mem.,' pp. 110 and 111), and endeavours to explain them as the result of an optical error. He remarks, and with great truth, that the spores of certain species, from their tenuity and other characters, closely resemble the paraphyses (*e. g.* among the Peltigereæ); that after emission from the theca they sometimes become entangled among the paraphyses, and may there germinate; and that in such a case true spores might *appear* to be generated *by*, instead of only *among*, the paraphyses. I have never seen the phenomena described by Berkeley and Babington, and therefore cannot vouch for the accuracy of their observations. But I have seen the terminal cells of the paraphyses, especially under the use of reagents, remarkably resembling gonidia or stylospores, or the cellules which I have described as generated, laterally and terminally, from peculiar tubes. Under the use of aqua potassæ, for example, I have seen the tips of the paraphyses of the apothecia of *A. Smithii* dissociated, the brown colouring matter dissolved out, and the obovate terminal cell occupied by a colourless globule or globules, giving it precisely the appearance of many of the stylospores of the same species. So long as we are ignorant of the origin, development, and functions of the corpuscles which I have mentioned, and while there is reason to believe

* 'Einiges über Lichenen und deren Befruchtung.' Bern, 1851.

Compare pl. i, figs. 11 and 12. "Einzelne fasern mit an den Enden und Seiten befindlichen runden Zellchen." Figs. 13 to 15. "Fasern mit Zellen der männlichen Gonidien-zellen."

Pl. ii, figs. 7 to 11. "Männliche Prosphysen—mit runden Endzellen"—"mit eiförmigen Verlängerungen"—"mit walzenförmigen Verlängerungen (abgeschnüret die Androsporen und noch einigen runden Zellchen)." Figs. 17 to 20. "Weibliche Prosphysen in verschiedenen Entwickelungs-stufen."

Pl. iii, fig. 12 *a*. "Losgelöste Prosphysen."

that we shall ultimately find the means of multiplication in the lichens wonderfully varied, and not at all in accordance with our preconceived notions, I consider it hazardous and improper to doubt or depreciate the observations of any botanist, and especially of men of such scientific eminence as the gentlemen whose names I have enumerated.

II. *A. oxysporus.*—I have already given so many details regarding the structure of *A. oxysporus*, in contrasting it with *A. Smithii*, that little now remains for me to add. Körber says, "Die übrigen Abrothallus-Arten [besides *A. Smithii* and *A. microsp.*] welche Tulasne noch unterscheidet, aber in Deutschland bisher noch nicht beobachtet zu sein scheinen, gehören, nach ihrem Sporencharacter, *nicht* in diese Gattung" (p. 216).

I cannot regard the mere character of the spore to be a sufficient reason for constituting species; else we should split up the lichens into an endless number. *A. Smithii* and *A. oxysporus* occur so constantly and intimately associated, the mode of evolution and growth of the apothecia in both is so precisely alike, and their apothecia are frequently so similar in external appearance, that I must look upon them as pertaining to one genus. The pycnides of the one, and the spermogones of the other, also serve to distinguish them; but I think only as species. I cannot here omit a protest against the unnecessarily and mischievously elaborate classification of Körber, who, in his last publication, enumerates in Germany 136 genera, while I feel assured less than one third would be found amply sufficient. It is this splitting up of species and genera; this multiplication of new and difficult names; this complete changing of old familiar terms, that operate as one of the most powerful barriers to the study of lichenology. It is only, I am convinced, by simplifying the science—by making genera and species as extensive as possible and thus diminishing names—by merging special peculiarities in general laws, that we can hope to make lichenology attractive. As a general rule, whenever *A. Smithii* occurs, *A. oxysporus* may be looked for. In the majority of cases, I found them growing together on the same thallus; under which circumstances it is very difficult to determine to which species to refer the spermogones and pycnides generally more or less plentifully intermixed. On Craigie Hill, I met with both species abundantly. In other localities the one or other predominated—*e. g. A. oxysporus* on Moncrieffe Hill, and *A. Smithii* on Ben Lawers. The geographical distribution of the Abrothalli seems very irregular, and is controlled by circumstances with which we are not

yet fully acquainted. I have never found them on the ordinary thallus of the common *Parmelia saxatilis* (the var. *leucochroa* of Schærer's 'Enum. Crit.') ; and I have looked for them in vain on furfuraceous states in a variety of localities. Mr. Leighton mentioned to me recently (*in lit.*) that he has never found Abrothalli in Shropshire, though he has frequently looked for them ; and that in Wales they are by no means plentiful. It is very desirable that collectors should direct attention to this subject.

The apothecia first appear about the centre of a squamule, where also the oldest and most fully developed specimens are to be found. The thalli on which *A. oxysporus* occurs are more frequently simple or polyphyllous squamules, and tend less to become globose and hypertrophic than those habited by *A. Smithii*. The young apothecia are punctiform, black, and scattered : they are frequently very similar to the spermogones, from which they can only be distinguished by the absence of an ostiole, and by microscopical examination. In the process of evolution, they more frequently fissure the cortical layer than those of *A. Smithii ;* the surface of a squamule is sometimes marked by a network of these fissures, which run into, or anastomose with, each other. In the old state the apothecia sometimes become tuberculiform or maculiform ; their surface is seldom raised much above the level of the surrounding cortical tissue, unless when moisture is applied. In the latter case the apothecium swells, the surface becoming more or less raised or convex. Moisture generally also changes its colour from a black to a light brown, but not invariably. The moistened, brown, swollen apothecium sometimes appears as if it were a discoid mass of gelatinous consistence. I have occasionally observed the apothecia depressed or saccate, as in specimens from the Highland road between Blairgowrie and Spittal of Glenshee. Tulasne says the apothecia are "punctiformia s. potius discoidea;" the former character appears to apply, however, only to young and undeveloped specimens, and not to normal mature apothecia. Besides the different effects of moisture on the apothecia of *A. Smithii* and *A. oxysporus*, the former remaining black, the section shows a deeper colour in the former than in the latter—black to the naked eye, but brown under the microscope. I have frequently observed sections of the apothecia of *A. Smithii* of a purple tint; while those of *A. oxysporus* have been invariably light brown. Besides the spermogones, the young apothecia are apt to be confounded with the pycnides of *A. Smithii*, and with certain parasitic fungi, which I have occasionally found interspersed : but these,

though bearing a close resemblance, to the naked eye, are generally more superficial, and their microscopic structure is quite different. I have, on several occasions, mistaken, by the naked eye, small, black, point-like parasitic fungi for the apothecia both of *A. Smithii* and *A. oxysporus*, among which they were interspersed; most frequently for the latter. I have also sometimes found them growing on these apothecia,—as in specimens from Glen Dee, Braemar, where they inhabit those of *A. Smithii*. They are generally, however, much more irregular in shape, being usually more or less rough, tuberculated, and flattened. On microscopical examination, they are found to consist of a cellular envelope of a more or less deep brown tint, enclosing myriads of very minute, globular brown spores. I have already stated that the apothecia of *A. oxysporus* may be saccate. On the other hand, they are sometimes so prominent and convex,—as in specimens from Loch Coruisk, Skye, that I have mistaken them for young deplanate apothecia of *A. Smithii*.

The thecæ, says Tulasne, "subito deorsum acutatæ et cuneiformes factæ." This is, however, only one phase of their existence, due to distension of the spore-sac and theca, with the maturescent spores,—the lower part, or pedicle, as I have already explained, sometimes tapering suddenly from the upper, which bulges into a sphere or obovate vesicle. The theca consists, the same observer continues, of a "membrana qua struuntur, crassissima et achroa, quum iode soluto roratur statim tota amœne spisseque cærulescit, talique modo tincta diu (scil. 20 horas et quod excedit) consistit." In regard to the amyloid reaction with iodine, the thecæ of this species contrast strongly with those of *A. Smithii*. I uniformly obtained a blue colour, which was generally best marked in young thecæ, and at the apex, where the membrane is thickest. In some cases the hypothecial tissue, and, in others, the intercellular substance, which glues together the tips of the paraphyses, appeared to strike a blue colour with iodine, especially during the young state of the thecæ. Tulasne refers to this circumstance in regard to the paraphyses: "Materie amorpha cujus ope adglutinari videntur abundat cæruleoque colore in iode confestim inficitur." I am not certain, notwithstanding, that this amyloid matter does not really pertain to the thecæ. The tips of the paraphyses are of a much lighter brown than those of *A. Smithii*; the colouring matter appears here also more diffused. Their apices are so closely united, that it is generally impossible, without the assistance of reagents, to discover the outlines or characters of the individual terminal cells. But aqua potassæ at once causes their

dissociation, and dissolves out the colouring matter, rendering distinct the terminal cell and its septum. In some cases a delicate colourless membrane appears to overlie and connect the apices of the paraphyses, but is really probably a thin layer of the mucilage or intercellular substance already referred to.

The spores are usually about $\frac{1}{1100}$ to $\frac{1}{1200}$ inch long by $\frac{1}{3000}$ to $\frac{1}{4000}$ broad; they are rather longer than those of *A. Smithii*, but about equal in breadth. They vary greatly both in size and form. Normally, they are ellipsoid, with acute extremities; colourless or pale yellow, having a double contour, and usually a lemon-coloured globular nucleus, arranged in the central axis, at either end. But they are sometimes lanceolate, fusiform, or caudate; or they are short and broad, swelling nearly into an ovoid or spheroid. In the latter case there is sometimes only one nucleus; or, if two, they are eccentric. In some cases the spores are empty, or full apparently of a homogeneous, colourless, oily fluid, resembling in this respect many of the stylospores; or they are filled with globules and granules of different size. The latter condition occurs in an abortive form or a permanently undeveloped type; and also in the old state, in which the nuclei become broken up into globules and granules. In certain states, when devoid of nuclei, the spores bear a resemblance to those of some Peltigeras and Stictas. Like the spores of *A. Smithii*, they appear to be arranged in the thecæ in a spiral manner. Their nuclei are much more constant in their occurrence than those of the spores in *A. Smithii;* they occupy those portions of the spore which, in the latter species, become the loculi. They germinate like many other spores, sending out a delicate filament from one extremity. They are, says Tulasne, "nucleo inæquali heterogeneo vixque (saltem de specie) oleoso gravidæ, in sinu cujuslibet asci inordinate generantur." I do not fully comprehend this description. The intra-thecal development of the spores I have already described when referring to those of *A. Smithii*.

The *spermogones* I have seen more or less abundantly in specimens growing on *P. saxatilis*, from Craigie Hill, Perth; Birnam Hill, Dunkeld; various parts of the Highland road between Blairgowrie and Braemar; various localities round Braemar; Ben Nevis; Barmouth, Wales, and other localities; and also on *Cetraria glauca* and *P. conspersa* from the latter locality. They occur as extremely minute, black, point-like bodies on the surface of the thallus, scarcely discernible by the naked eye. With the aid of a good lens, each of the point-like spots is found perforated in its centre

by a simple or stellate ostiole or pore, with flat, more frequently raised, and sometimes, but rarely, depressed borders. Even under the lens, and especially in young spermogones, the pore is often imperceptible. It may be made more prominent by moistening the spermogone, whose tissue is very hygrometric, swelling rapidly and greatly in water; the ostiole becomes thus more patent, and its edges better defined. With age also the ostiole becomes more open and generally stellate, the cavity of the spermogone being empty and its walls hardened. In old spermogones also the depressed or saccate character of the ostiole is occasionally observed. The ostiole leads into a somewhat spherical and simple cavity, whose envelope consists of a brown cellular tissue, and whose internal walls are lined by a compact series of sterigmata,—arranged perpendicularly to the spermogonal walls, and convergently to the centre of the spermogonal cavity,—generating from their apices myriads of spermatia. When moistened, the spermogones assume a light brown tint; and when the thallus or matrix is moistened and viewed by transmitted light, they constitute a series of brownish, translucent, round spots, amid the surrounding dull opaque green (of the gonidic layer shining through the brownish cortical tissue). The sterigmata are simple, cylindrical, or almost linear cells, frequently very irregular in form, being sinuous in their outline, and presenting bulgings or bendings. On tracing carefully their connection with the walls of the spermogone, they appeared to me to be given off as a series of hollow buds, at irregular intervals, from a peculiar tubular tissue. The wall of the parent-tube presented a bulging which became dilated and elongated into the form of a sterigma. From the apex of the latter a smaller bud was developed, which became elongated into a linear, very slender, straight rod-shaped body; on attaining a certain length, a septum became visible at the point of junction between this body, the spermatium, and its sterigma, and a severance took place. The sterigmata often came off in groups from the parent-tubes, and, when elongated and narrow, not unfrequently resembled the fingers of the hand. Sometimes the sterigmata were nearly as narrow as their spermatia, into which they gradually tapered. The spermatia were either seated perpendicularly on the apices of the sterigmata, or they came off at various angles, which were occasionally very acute. In the latter case there was frequently a bulging or dilatation of the sterigmata immediately before they gave off the spermatia.

The *spermatia* between about $\frac{1}{4000}$ and $\frac{1}{5000}$ inch long. I

had abundant opportunities of observing the peculiar, wriggling, swimming, and diving motion which has attracted the attention of so many lichenologists, and given origin to so many ingenious theories as to its nature. But I see no reason to doubt for a moment that it is merely the molecular or Brownian motion now so familiar to botanists. The movements occur only in free, isolated, floating spermatia; *en masse* they are at perfect rest. Iodine had no effect on the spermatia or sterigmata further than communicating its own tinge; but the network of tubes from which the latter spring, or the intercellular matter, appeared sometimes to assume a bluish colour.

It may be advisable here to point out the resemblances and differences between the spermogones of the Abrothallus and those of *P. saxatilis*. I have examined the spermogones of *P. saxatilis* on various furfuraceous forms from Norway, Ben Lomond, the Kyles of Bute, and other localities. In external characters they closely resemble those of the Abrothallus. They occur as extremely minute, black points scattered over the surface and towards the extremities of smooth laciniæ. Each spot is perforated by an almost imperceptible ostiole—simple or stellate—which leads into the spermogonal cavity. The sterigmata which line its walls, however, are very different from those of the Abrothallus. Here they are equally delicate and narrow; but they are articulated, ramose, and much longer. There is, however, a great want of uniformity in length, some of them projecting far beyond the others. The articulations consist of simple, cylindrical cells, generally joined to each other at more or less irregular angles. Spermatia are given off perpendicularly, or at various angles from the apex of each articulation; consequently the sterigmata generate spermatia both from their apices and sides. The latter, indeed, appear to come off from the former as a series of minute lateral branches or buds. The spermatia are very abundant; they are about the same length as those of the Abrothallus, but they frequently appear more slender. Körber describes "Spermogonien auf den Runzeln des Lagers als schwarze gehäufte Wärzchen bisweilen wahrnehmbar, mit sehr kleinen, *fast kugligen* [?] Spermatien" (p. 73). In addition to the sterigmata there arises from the walls of the spermogone a series of very delicate ramose filaments, which project far beyond them, and fill its cavity with a delicate network formed by their anastomoses and ramifications. These filaments are sterile. Sometimes they are articulated or septate at the extremities, which may appear proliferous; but this is pro-

bably an illusory appearance due to adhesion of some of the abundant floating, free spermatia. These filaments generally terminate in a rounded bulging extremity, the interior of which contains a more or less finely granular material. From their abundance, growing as they do from among the sterigmata, they are apt to conceal the latter. They occur also in the spermogones of several other lichens—such as *Parmelia physodes*, and some of the *Ramalineæ* and *Umbilicariæ*. The nature and function of these peculiar filaments have not hitherto been determined. Possibly they are abortive and hypertrophied sterigmata; or their terminal cells are thrown off as accessory reproductive bodies of a kind with which we are as yet unacquainted. Further researches of course are necessary to settle this point.

In specimens of *A. oxysporus*, growing on *P. conspersa*, the spermogones of the Abrothallus and Parmelia are apt to be confounded. One of the most prominent characters of *P. conspersa* is its black-punctate thallus; hence, indeed, its very appropriate name. The minute black points, so abundantly scattered over its surface, are the spermogones. These thalline spots are each perforated by an ostiole which leads into the cavity of an immersed, spherical, one-locular spermogone. Here, however, as in the analogous case of *P. saxatilis*, the resemblance ceases; for the sterigmata and spermatia are much more delicate or slender, and the former are articulated, each joint being a narrow linear cell. Its spermogones are frequently also dotted over the outer surface of the thalline exciple of the apothecia, and also on the hypothecium, after the falling out or erosion of the hymenium or lamina proligera. The falling out of the latter leaves a saucer- or cup-shaped organ of similar colour to the thallus.

In searching for spermatia, it is necessary to bear in mind that the spermogones precede, in order of development, the apothecia; and that, by the time the latter have attained maturity, the former have been long since emptied of their contents. Young spermogones containing spermatia should, therefore, be looked for on young or sterile thalli or lobes, or on those bearing only nascent apothecia. I have found the spermogones in best condition on portions of thallus destitute of apothecia. The same remark may be applied to the pycnides of *A. Smithii*. Though strong grounds exist for regarding the spermatia as fertilizing or impregnating corpuscles, the process of impregnation has not been hitherto detected in lichens. It still remains a problem for microscopists. The discovery of spermogones in lichens has already

made, and is destined still further to create, great changes in our knowledge of the structure and classification of the more minute lichens. It has been lately determined that the genus *Pyrenothea* constitutes the spermogones of various more familiar lichens,—*e. g.*, *P. leucocephala*, Fr., consists of the spermogones of *Lecidea abietina*, Ach., and *P. vermicellifera*, Kunz, of those of *Biatora luteola*, Fr.

"Pycnodites nondum innoturunt," remarks Tulasne tersely. This statement my own experience—as I have already mentioned in describing the pycnides of *A. Smithii*—enables me to corroborate.

The existence of BIRDS *during the deposition of the* STONESFIELD SLATE *proved by a comparison of the* MICROSCOPIC STRUCTURE *of certain* BONES *of that formation with that of* RECENT BONES. By the Rev. J. B. P. DENNIS, F.G.S., Bury St. Edmunds.

FROM extensive observations made upon the bones of birds, I find that, in their microscopic characters, their bones are as distinct from those of mammifers as the latter are from the bones of saurians. As the lacuna in the saurian bone exceeds that of the mammal in the size of its canaliculi, so does the latter exceed that of the bird;* and as they are more numerous and more branched in the bird than in the mammal, so in like manner are they more so in mammalian than in saurian bone.

It is in birds that the Haversian tubes attain their most elegant and varied reticulations, not fortuitously, but with design, and that intimately connected with the life and habits of the animal. In fact, each bone is a study in itself, and involves a knowledge of the muscles that move it as well as of the use it is designed for; and in a bird of flight the shape of the wing, the extent of the surface covered by the quill feathers, whether it is pointed or round, whether the secondary quills are strong or weak, are all matters of deep consideration, and comparison with the internal structure of the bone, which the microscope reveals to the eye. I feel that I need the powers of the consummate naturalist and

* This, of course, is speaking generally. I do not observe much difference between the canaliculi of the hare and those of Bewick's swan as to size. Again, the lacunæ of the mole are as small as those of birds, but then. the Haversian tubes totally differ. As a general rule, the bone-cells in birds are smaller than they are in mammifers.

comparative anatomist, to do entire justice to the subject. All I can hope to do is to pioneer the way, and furnish fresh data from which science hereafter may perhaps draw her unerring deductions. My present object is to prove, from a general exposition of the structure of birds, that they had representatives on this planet when the Stonesfield Slate was still the soft mud of a large estuary; and I purpose, for the thorough elucidation of the question, not only to consider the structure of birds, but also of those mammifers and saurians which more or less approach birds in their power of flight, for they are intimately (especially the Pterodactyle) connected with the subject. Amongst mammifers, the bats alone have the power of maintaining a continued flight, by the rapid vibrations of membranous wings, which are in fact but a modification of the arm and hand, so adapted as to enable them to extend a thin canvas by which their bodies are conveyed through the air. To this end the fingers are greatly increased in length, as well as the humerus and radius; the scapula also is large, and lengthened in a slanting direction at its lower portion, for the better attachment of muscular power, and to afford greater support to the stroke of the wing; the clavicles are curved like the furcula of the bird, and perform the united functions of the furcula and coracoids, preventing the compression of the chest and keeping the humerus in its place when acted upon by the pectoral muscles. It must, however, be borne in mind, that there is no deviation in this flying mammal from the plan Nature has laid down in the construction of mammifers; the bat, because it flies, is not a bird, no more than the bird that swims and cannot fly is a fish. If you examine the fin of the penguin, you will observe the same plan of construction that exists in the wing of the eagle; so the wing of the bat is in accordance with the same design that framed the hand of man. Nature can adapt without confusion, and although, as Cuvier says, the bats seem to have the appearances of wings—"Un examen attentif démontre que ce sont de véritables mains, dont les doigts sont seulement un peu plus allongés."

The bones of bats are excessively strong, hard, and semi-transparent, the radius is a long bone curved laterally and inwards like a bow. Along the convex surface runs the extensor muscle with its tendon, which crossing over the carpus becomes connected with the tendons that extend the fingers. On the opposite side of the bone is placed the muscle and tendon that closes the wing. The ulna in bats is either absent or rudimental, the muscles of the forearm are

exceedingly insignificent when compared with those of birds; their bones are harder in texture, and only the very large bats possess Haversian tubes, for even the largest indigenous to this country are without them,* and the *Pteropus*, the largest of the family, has only short and straight ones, and these not at all numerous. Not carrying elastic and powerful quills, the bat does not need the same muscular development that is necessary for the bird, a simpler power of extension and flexion of the wing is all it requires in its forearm; where great muscular power is wanted there it has it. The chest is enormously developed, the ribs are strong and flat, the sternum has a ridge, the scapulæ are approximated to those of the bird, and the whole strength of the animal is concentrated in the chest and shoulders. In fig. 1, plate VI. are shown the Haversian tubes and lacunæ of the *Pteropus*, or flying fox as it is popularly called; the Haversian tubes are more like long lacunæ, and are, in the humerus, straight, unconnected, and not numerous, but the lacunæ are very abundant; these become more fusiform in the phalanges, as may be seen in fig. 2, which represents a phalanx with its medullary cavity of one of our small bats. The canaliculi of the bat are large for mammals. The Haversian tubes in the phalanges of the *Pteropus* are longer and finer than in the humerus, and a slight ramification is seen in the extreme ones. I conceive the reason of the paucity or absence of these tubes in the bats, is to be found in the character of their wings, and the habits of the animal. Bats require light but strong bones, hardly at all flexible, for were they so their great length and slenderness would make the wing so pliable, that it would be powerless in resisting the air, and thereby enabling the animal to sustain itself in flight. Lightness is obtained by numerous lacunæ, and numerous and comparatively thick canaliculi, and no more elasticity is imparted to the bone than is sufficient to preserve its structure, and obviate any fracture, in flight. In the bird, on the contrary, elastic resistance to muscular pressure is of much importance; and hence appears to have arisen that admirable application and adjustment of the Haversian tubes, so conspicuous in the economy of birds. Besides bats, there are other mammifers, such as the *Galeopithecus*, flying *Phalangers*, &c., which, though they do not fly in the true acceptation of the word, yet are enabled to perform flights to some extent in the air by the aid of a

* I have found them in the *jaw*, a thick stem with a few straight branches between the fangs of the teeth. The jaw is a good object of comparison with that of the mole. (*See* p. 76.)

lateral extension of their skin, which being spread out like a parachute sustains them for some time. I have examined the leg-bones of two species of flying *Phalangers*, and a few words will be necessary about them. In such animals lightness and elasticity, but especially the former, are of paramount importance. In the smaller flying *Phalanger*, the Haversian tubes, especially in the tibia, are large and numerous, the lacunæ are very numerous, and the canaliculi large; every particle of unnecessary weight seems to have been abstracted from their bones, that the light animal may float almost like a feather in the air. Fig. 3 gives the appearance of the Haversian tubes in the tibia of the smaller species; they are disposed in the most advantageous manner, running in parallel longitudinal courses, with only an occasional junction between them.

Amongst recent reptiles, the *Draco volans* is enabled, by an extension of its false ribs, to expand a fan-like membrane, by which it can, like the Phalangers, for a little time sustain itself in the air. I have examined also the bones of this most interesting reptile; they are hollow and thin, but strong, without Haversian tubes, and having very numerous lacunæ; the canaliculi are fine for a reptile, but partake, in other respects, of the reptilian characters. The ulna of the *Draco volans* compares very much with that of the frog in the character of its lacunæ; in the femur they approach more those of the *Phalanger*; there is, however, an admixture of roundish lacunæ, but this admixture is apparent also in the bones of bats. As the animal is an agile climber, strength in its bones is as requisite as lightness; and as the parachute is altogether disconnected from its limbs, it would seem to be with the intention of giving them absolute freedom—the long ribs being mobile, and the membrane folding up by the creature's sides until occasion requires its expansion, offering no impediment in the way of its progression (fig. 4 represents the ulna).

Before I make any remarks upon the Pterodactyle, I would describe some of the leading features of the bones of the gannet, and say something of the structure of birds in general. The gannet being peculiarly characterised by the length of its wing-bones, is a very appropriate bird to compare both with the bats and Pterodactyles; its habit is to take its finny prey by falling headlong upon it with immense velocity, and often from some height. It possesses to a surprising extent the power of inflating its body with air, and from the great buoyancy of its body would seem to be incapable of diving, and, though web-footed like the cor-

morant, is said to have no predilection even for swimming; as, however, the force by which it descends, evinced by the cloud of spray it scatters around, must have the primary effect of carrying the bird to a great depth, unless resisted by muscular power, aided by the buoyancy of its body, its legs become powerful instruments in bringing the gannet to the surface so soon as it has secured (as it never fails to do) its prey. The bill of the bird is strong, without clefts for the nostrils; the furcula strong and bowed out, and the portion especially that meets the resistance of the sea is bent down at about a right angle with the coracoid, and it is there excessively strong, with a powerful articulation and a pointed process, extending for half an inch on the inside—taking the furcula, coracoids, and breast-bone together, they form an admirable piece of machinery, adapted to the habits of the bird. The keel of the sternum is small and thrown forwards, so that the outer edge and the furcula constitute an extended arch, very different to the depressed character of the furcula in the shag; the keel of the breast-bone is straight, without any curve, as in the shag. The socket also, where the coracoid fits into the sternum, has a very strong and expanded articulating surface, and there is an impression both in the sternum and the coracoid for an oblong ligament, which braces the coracoid strongly to the sternum; on its outer edge it is not truncated as the shag's, but is shaped like the point of a bill-hook. I will now, however, describe the microscopic structure of some of the principal bones. The humerus, radius, and ulna partake of the characters I have observed in all birds whose wings are long and pointed. In the humerus vertical section (fig. 17), the Haversian tubes do not reticulate, but run nearly parallel, and ultimately converging to a point, from which extends another tube which converges in a similar manner. The lacunæ are long, and, for the most part, narrow; in the transverse section the Haversian tubes appear as round dots, the lacunæ as small, irregular specks, and the canaliculi beautifully reticulate. The ulna compares very nearly with the humerus; in the radius the Haversian tubes are more numerous, more parallel, with fewer connections; the lacunæ also are rather longer. There is nothing particular to notice in the scapulæ, the Haversian tubes observing a pretty similar arrangement; but the furcula, and especially the coracoids, are worthy of particular notice.

In the furcula (fig. 18) the Haversian tubes are not so numerous as in the humerus, have no connections, and the lacunæ are very fusiform. In the coracoid (fig. 19) a

complete change and one anomalous, so far as I have observed, in the structure of that bone in birds, takes place; in the vertical section the Haversian tubes are beautifully and regularly reticulated, the reticulations forming circles generally of a very regular form, and the long and fusiform lacunæ are replaced by roundish ones; in the transverse section the Haversian tubes appear as truncated branches, and the lacunæ are large, which would seem to indicate that their form is pretty circular. The femur of the gannet (fig. 20) very nearly compares with the coracoid, without so much regularity in the Haversian circles; the lacunæ are often roundish oval, sometimes irregular, or long and thickish. In the transverse section (fig. 21) the Haversian tubes appear in parallel rows, with the excised ends of others between; the lacunæ have irregular canaliculi, beautifully reticulated. In the tibia (fig. 22) vertical section the Haversian tubes run longitudinally, with numerous transverse, diagonal connections, characters not at all uncommon in the same bone in other animals; the lacunæ are small sharp-pointed ovals, and differ little either in the vertical or transverse sections. In the tarsus the Haversian tubes are not so numerous, but very much thicker, and also of variable dimensions; in the toes the reticulations are numerous, but not circular, and rather appearing as traces to the longitudinal tubes. In the rib (fig. 24) of the gannet there is a striking correspondence in the characters and paucity of the Haversian tubes with those of the humerus of the *Pteropus;* and we may also notice, in the furcula (fig. 6) of the swift, the same diminution of the Haversian tubes, a bird of very peculiar construction in its wing, with an enormous muscular development. The swifts have by far the shortest humerus, and the longest metacarpal bones and phalanges, of any bird I have dissected.

The sternum of the gannet, being exceedingly transparent, affords an excellent view of the coarser Haversian tubes without the use of the microscope; in the keel they radiate from the thick portion, where the coracoids articulate, like the spokes of a wheel to the edge, appearing looped and braced; in the sternum plate they are bowed outwards from the central line towards the coracoids, being very close together, with numerous cross braces; in the ilia they run longitudinally with much reticulation at the edges; in the flat surface of the back, behind the sockets of the femur, they pass across to the anchylosed vertebræ, being met by others at right angles that extend longitudinally along the narrow part of the bone until they approach the pelvis, when they reticulate until they are lost sight of in the thickness of the

bone. There is nothing particular worthy of notice on this occasion as to the other bones.

The structure of the gannet, so far as I have described it, in the principal bones, admirably exhibits the beautiful adaptation of the microscopic structure of bone to the movements, habits, and well-being of the creature, and in no bone is that adaptation more clearly shown than in the coracoid —the circular reticulations of the Haversian canals in which bone are assuredly designed to enable it to sustain the shock it must receive when the bird impinges on the water; the powerful bill first cleaves the waves, the strong bows of the *furcula* next meet the shock, and the injurious effects of the concussion, which would perhaps be too much for an ordinary coracoid, are obviated by the circular disposition of its Haversian canals. But this is only a single instance. We find wonders of omniscient providence in every skeleton. How admirable is the design displayed in the keel of the sternum. Take that of the heron, for instance; the same tender care is shown for the preservation of the bone when acted upon by the powerful pectoral muscle. It is composed of two plates, with diploë between; the Haversian tubes in the plates meet the pressure at all points. Examine the tibia of the same bird, and it will be found that they are longitudinal in the reticulations. Or if we turn to another kind of bird, the starling, for instance, we find beautiful reticulations in the ulna, with straight Haversian tubes in the coracoid, the very opposite of the gannet. Or if we examine the wing-bone of the razor-bill or guillemot, which is used by the bird to swim with under water, and seldom for flight, we observe not only an external adaptation of the bones, but the microscope shows also that there is an internal one as well. And from the numerous observations which I have made, no doubt whatever remains in my mind as to the important ends and services of the Haversian tubes, lacunæ, and canaliculi.

There are not two bones in animals, unless they are of the same kind, that agree perfectly in the arrangement of the Haversian tubes, or even of the lacunæ; hence the certainty, as our knowledge increases by careful observations, of ascertaining the habits of any animal from the microscopic characters of its bones, a truth which I surmised and hinted at in a previous paper.

That the size of the canaliculi is dependent, as has been supposed, on the size of the blood discs does not appear to be supported by observation; but that it is dependent upon the habits and requirements of the animal observation tends to show. The lacunæ and canaliculi not being of universal

occurrence in fish, seems to show that when they are present it is for some other purpose than the transmission of blood discs to the bone. Again, why should the lacunæ be of different shapes even in the same bone? Surely this can only be explained upon the hypothesis of their connection with the structure of bone, as that is connected with the life of the animal. The canaliculi also seem to differ in size, as in the femur and bone plates of the back of the armadillo. I think the facts I have adduced tend to throw light, not only upon the general structure of bone, but also upon the variation that appears in fishes. In the fin-bone of the sturgeon the lacunæ are assembled in masses, so also in the dermal plates; and the bone of the plates is excessively hard for fishes' bone. It would appear that a combination of strength and toughness is thus imparted to a greater degree than would be given by any homogeneous mass of bone. The very principle has been carried out in the tubular Menai bridge, which has numerous cells or compartments, which add infinitely more to the strength and stability of the structure than if it had been a homogeneous mass; and besides, by the dispensing with superfluous matter, a reduction of specific gravity is also obtained. For ordinary purposes, the gelatinous, homogeneous bones of fishes* seem sufficiently strong for their mode of living, but a much more elaborate structure is requisite in the higher Vertebrata. Only examine the fine structure exhibited in the bones of the lion or the horse—animals which require strength combined with lightness and elasticity or resistance to violent shocks in their bones. The canaliculi of the lion, which possesses great strength, and the horse, which can carry or draw great burdens, are in both numerous and fine. In the whalebone whale, which descends to great depths, they are also numerous and fine; in the elephant, where massive strength is required, they are not numerous. In the *Icthyosaurus*† and *Plesiosaurus*, the canaliculi, though finer than those of some other saurians, are few in number; hence their bone is perfectly distinct from that of mammifers or birds; they have also, at least in parts, straight Haversian tubes. Thus the whole structure of bone is a portion of animal mechanism which, when thoroughly

* Some have, as the cod, Haversian tubes without bone-cells: they are seen well in the vomer.

† Haversian tubes, or the semblance of them, I have only as yet found in the jaw; in the ribs it appears to be an extension of the cancellated structure, of which, in fact, the bone of that animal seems to be composed. The small paddle-bones are very curious, and have a singular complicated set of bone circles at their edges. The peculiar cancellated cavities I at first mistook for Haversian tubes.

understood, may prove of service in the arts and advance the mechanical powers of man. Comparisons with the same bones in birds of similar flight and configuration of the wing are highly useful in elucidating this subject. Take, for instance, such birds as the ring-dotterel, turnstone, dunlin, pigmy curlew, little stint, and other birds of that description, whose mode of flight is so similar that I will defy the most practised sportsman to distinguish one from the other by its flight. Now if we examine a portion of the ulna, taken from the same part of the bone in any one or all of these birds, we shall at once observe a similar and singular correspondence in the disposition of the Haversian tubes. Examine next the ulna of the greensand piper, a bird whose wing is broader than, and not so pointed as, the above mentioned, and whose flight is easily recognised from its congeners by the sportsman, and you will notice an entirely different arrangement of the Haversian tubes, which are reticulated in every direction, while in the rest they observe longitudinal directions; what conclusion can we arrive at, but that these tubes are arranged in accordance with the flight of these birds. The starling, the raven, the jay, &c., have all fine and numerously reticulated tubes, and the secondary quills of all these birds are well developed. In the fowl they are very powerful, and the ulna contains numerous and fine tubes; in the owls the same; in the hawks the Haversian tubes are large and much reticulated, and are easily recognised from those of other birds. It seems, therefore, possible, from the microscopic structure of the bone of a bird, to divine the shape of its wing and the character of its flight, there being a perfect correspondence the one with the other, just as a perfect knowledge of the femur will inform us whether a bird could swim, or only run, or walked; and this may be done even in a fragment of a bone, after we have acquainted ourselves with the general principles by very numerous and exact observations.

In the coracoid, for instance, the ordinary disposition of the Haversian tubes would be longitudinal, braced more or less, because that would be the best arrangement to resist the powerful action of the pectoral muscles. In the gannet, as has been shown, a circular arrangement is preferable, but this is apparently an exception, and connected with the peculiar habits of the bird. The ulna of the razor-bill and guillemot is more reticulated than would primarily be expected in the wing of a bird where the secondary quills are so very weak; but then it must be considered that those birds use their wings much more like fins when under water than as

instruments of flight, as they seldom take wing, but invariably dive, when they are approached, and may be observed to use their wings under the water with surprising ease and agility. The wing, in fact, is more constructed like an oar, and the bones are flat, especially the humerus, and the wrist is strongly braced to the forearm. The ulna and femur of the red-throated diver exhibit a very singular sort of sinuses in the Haversian tubes, which seem to swell out; the structure of these is peculiar, and at present I have not been able quite to make it out, there being a great deal of oily matter in the bones of these birds.* I have observed a structure of bone something similar in the medullary cavity of the ulna of the *Draco volans* (fig. 4). The tibia of the red-throated diver (fig. 5) is introduced on account of this peculiarity. The goosander exhibits somewhat similar reticulations to the Stonesfield fossil.

Having so far given the general features of the microscopic characters of the bones of birds, we may now attempt to grapple with the microscopic structure of that most singular reptile the pterodactyle.

The *Pterodactylus longirostris* perhaps affords us the most perfect means of studying the singular proportions of its skeleton. A larger and less-perfect, but exceedingly useful one, was discovered by Miss Anning, at Lyme Regis, and which is now placed in the British Museum. Also portions of the jaws of a very large kind have been discovered in our Chalk formation, with other bones now supposed to have belonged to a similar animal. From these specimens we learn that the animal was a true saurian, apparently adapted for flight, and for arboreal and terrestrial movements, and instead of possessing, like the bat, an extension of all the fingers, it had only one prolonged, the others being used for progression; it differed also from the bat, in having a well-developed ulna as well as a radius. There did not, however, exist between them the space, that, in birds, is adapted to receive so much muscular power; but as the forearm performed double the duty of that of the bat, we may reasonably suppose that its muscles were more numerous. In the bat, the extensor of the fingers is a small muscle, which, arising from the external condyle of the humerus, and, passing over

* I find in the lower jaw of the *Pteropus* numerous Haversian tubes, parallel with the length of the jaw, and having enlargements or sinuses in them very similar to those in the red-throated diver. Surely this is a further proof of the adaptation of the Haversian tubes to the habits of the animal. The tubes are also branched and connected, very different to the way in which they appear in other parts of the skeleton.

the carpus, sends forth extremely fine tendons over the convex surface of each of the fingers, terminating in the last joint. In the pterodactyle, the digitus auricularis that forms the wing, would seem to require proper extensors and flectors; and we may suppose that the pterodactyle, in some degree, in the use of its limbs, approached the frog; we also may assume it possessed extensores carpi radialis and ulnaris, an extensor digitorum communis, also an extensor proprius digiti minimi (auricularis), as well as flexores carpi radialis and ulnaris, a flexor digitorum communis, a flexor proprius digiti auricularis, and possibly a pronator and supinator. The bird, indeed, has two muscles which occupy the place of the pronator teres, which are not used for pronation but flection. We may therefore imagine that the muscular development of the forearm of the pterodactyle was something between that of the bat, frog, and bird. The presence of quills in the bird has evidently materially affected the muscular development of the forearm; as also their being bipeds involved a greater development of the muscles of the leg, it would be, however, unnecessary to enter upon them. In the pterodactyle, the strain upon the bones of the wing would be principally in the long direction, there being no lateral pressure, from feathers being attached to the bone. In the bird the quill feathers are a very important element, and it has been shown that the Haversian tubes vary according to the shape and uses of the wing; but there is no reason to suppose that any such variations would be required in the pterodactyle. In the *Phalangers* they extend longitudinally; we may therefore suppose that such was principally the case in the pterodactyle; we have every reason to conjecture this from analogy. Take, for instance, the bill of the pelican, which is long; how do they run? longitudinally; or the tibia of a heron? longitudinally also; or in the spiculæ or shafts of bone that shoot across the interior of the humerus of a goose, or in the ordinary coracoid of a bird, the same direction is observed.

Next, with regard to the lacunæ; of what shape would analogy teach us to expect them to be in the pterodactyle? Surely long pointed ovals; as indeed they have been so figured; only the mistake made was the supposing such a shape was peculiarly characteristic of the pterodactyle; whereas the shape of the lacuna is characteristic of no class or order of vertebrate animals, but is only connected with the requirements of the bones of the animal, and may be long or round in the same animal as occasion requires.* The

* Our common roach beautifully exhibits this.

lacunæ, in fact, obey the same laws as the Haversian tubes do, and are placed in that position, and are of that form, which best suits the necessities of the bones they constitute a portion of.

Since I had written the above remarks, I have very opportunely received a portion of a bone from the Chalk, through the kindness of H. Catt, Esq., of Brighton, which precisely exhibits these characters. The Haversian tubes are principally longitudinal, the lacunæ are long like those in the bill of the pelican; and, indeed, the Haversian tubes very nearly compare, especially in size. There is, however, a peculiarity in the bone which I was not altogether prepared for, having observed it in no bird-bones, though I have noticed something like it in the frog. It is the way in which the lacunæ cross.* There appears to be a set running longitudinally, and a set above them running in the opposite direction, which gives a very *marked and peculiar* character to the bone, and makes me think that this bone, which came from the Chalk, and which is a hollow bone with very thin walls of a peculiar texture, is pterodactyle bone; another thing further confirms me in this view, the canaliculi are not numerous like those of birds, and coarser (it is figured in figs. 7 and 14); if so this is a further confirmation of those general principles I laid down in a previous paper on the characters of bone—the pterodactyle, though it could fly like the bird or bat, yet showing its saurian characters, both outwardly and inwardly, in its bones. The fossil bone from Stonesfield, which I have selected for comparison, is in the possession of W. Adams, Esq., of Buriton, Petersfield, who has very kindly furnished me with other most interesting fossils; and I have chosen this from several other supposed fossil bones of birds from Stonesfield, as one of the greatest interest, from its striking similarity in structure to the humerus of the heron. It belonged, however, to a smaller kind than our common heron, and appears from a drawing, (for I have only received fragments of the bone,) to be the distal end of the humerus; the bone has quite the texture of bird-bone in its outward appearance, and is decidedly different from that of the pterodactyle from the Chalk, which looks rather silky, an appearance apparently caused by fine lines on its surface, which the bird-bone is free from.

The vertical section of a portion of this bone gives the following characters: Haversian tubes for a bird of medium

* I have since observed something like this crossing in the skulls of some birds and the bone plates of the armadillo.

thickness; reticulate, but without any precise form or size in the loops, but rather a marked irregularity is shown, some appearing square, others triangular, others oval, in fact of all shapes and sizes; sometimes they somewhat interlace; they do not entirely maintain a uniform diameter, the reticulations are inclined to form combinations, which produces a variety in their appearance, sometimes two or three of a similar shape and size uniting. The lacunæ are numerous, small ovals, and round, but more pointed ones than round. The canaliculi are fine, much branched, and very numerous. That this is the bone of a bird, from the evidence I have adduced, there can be no doubt. My object is rather now to attempt to discover what kind of bird it might have been. We have no reason to suppose it belongs to the *Raptores*, for it does not exhibit their peculiarities of structure, the Haversian tubes being peculiarly large in the diurnal birds of prey. Neither did it with much probability belong to the *Corvidæ*, for in them they are finer and more reticulate; still, neither did it belong to the *Columbidæ* or the gallinaceous family. All the goose, duck, and gull tribes, with the divers, perhaps mergansers, cormorants, &c., may also be excluded, for they have, as far as I have examined them, marked distinctions. By this process of separation we have narrowed the field of our research, which leaves us with the cranes, herons, egrets, and bitterns, and birds of that description, to discover a living representative of this ancient bird. But for the present, I shall only attempt to show that our common heron exhibits a very marked agreement in many particulars.

The bones of the heron, like those of other animals, exhibit a varied adaptation of the Haversian tubes, and certainly do not at all compare with the fossil in some of them, as the tibia for instance; but in the humerus there is a very great similarity, more so than in the ulna or radius. The Haversian tubes in the humerus appear to be constructed on the very same plan, so that a description of the one would be only the counterpart of the other, only they appear rather larger in the heron. The lacunæ have also the same shapes, with nearly the same admixture of round ones; the heron appearing to have a greater number. The canaliculi also perfectly agree. Supposing the fossil bone to have been a humerus, its correspondence with the humerus of the heron would indicate that its wing was similar in shape and its mode of flight corresponding. Should further investigations substantiate this surmise, it will be another triumph of the microscope in the field of science.

Addenda.

The general truth of my observations may be easily tested by an examination of the bones of some of our common animals, such as the hare, rabbit, squirrel, rat, mole, &c. As mere microscopic objects, they will repay all the trouble; and the only apparatus required will be a fine saw, which is best home-manufactured out of the main spring of a watch; a small hand grindstone; a common slate hone; and a piece of leather to guard the fingers. Both a cutting and a writing diamond will also be necessary. If the person is residing in the country, let him take a walk to the first gamekeeper's residence, and ask him to show him where he hangs the vermin; or let him look out for a bush where the mole-catcher hangs his moles; or if he has rabbits for dinner, let him save, to the utter astonishment of his servants, the bones. The dainty morsels conveyed home, a rich mental feast is soon prepared. Let me suppose the operator compares the metatarsal bone of the rabbit or the hare with one of the polecat or the mole. He will find numerous Haversian tubes in those of the rabbit and hare, not half so many in the polecat, and quite a different arrangement in the mole, with complicated reticulations at the ends, and few Haversian tubes, and of a peculiar character, in the shaft, quite distinct from the rabbit, &c. If the whole under jaw of the mole is ground down, the Haversian tubes will be found to send up a tree-like stem between the fangs of the molars, with branches across. The under jaw of the weasel is a very suitable object to compare with the mole; and their distinctive characters are easily recognised. The parietal bone of the mole is also a nice object for comparison with that of the weasel, and in the latter the Haversian tubes are much reticulated, and compare more with those in the joints of the hind metatarsal bones of the mole; that is, they have that complicated character. Now, the weasel is remarkable for a very powerful muscular development in its head; and so its jaws show, in their microscopic characters, great strength of action; and the play of the powerful temporal muscles is registered in the disposition of the Haversian tubes, which are more open in the mole, and less complicated in their character. Let next be picked out one of the little vibrating bones from the ear of the mole—it is itself almost microscopic, but grind it down, and it will be seen to be marvellously full of highly reticulated Haversian tubes; or let the lower jaws of the rabbit, hare, squirrel, and rat, be taken, and let

a piece be sawn out just under the long incisor tooth; the piece from the rabbit will be found to be full of fine tubes parallel with the tooth; that of the hare with coarser and more irregular ones; in the rat few, and only the truncated ends, will be seen; and in the squirrel none at all.* Do not these variations accord with the habits and mode of life of these different animals; the rabbit and the hare can neither gnaw a hole through wood, nor extract the kernel from a nut; but the rat can do the one in a masterly fashion, and the squirrel the other. But I might multiply an infinity of instances until I became tedious, and it is better that microscopists should work them out for themselves. I merely exhibit a few instances out of many from which I have arrived with certainty at the law that governs the texture and composition of bone, which may be thus briefly explained:

That the Haversian tubes are connected with the movements, habits, and mode of life of the living creature in which they may be present.

That the lacunæ obey the same law, and adjust themselves to the strains, pressure, and requisite density of any bone.

That the canaliculi serve it also, and yet without any confusion of the great classes of vertebrate animals.

That all conspire in evincing the admirable unity of design, and the harmonious correspondence of the bones with the muscles, tendons, &c., of an organized being; so that while each living creature obeys the general law, each maintains also its distinctive characters.

* Perhaps an odd one may appear, the cut requires to be carefully made, as there are Haversian tubes on the side of the jaw, but different to those of the rabbit. At the extreme edge there are round holes in the bone, these are much more developed in the rabbit; the course of the bone-cells is irregular, mostly across, whereas they run longitudinally in the rabbit.

On Dysteria; *a new genus of* Infusoria.

By Thomas H. Huxley, F.R.S.

The credit of the discovery of the animal which will be described in the following pages is due to my friend Mr. Dyster, of Tenby; and many of the most important statements regarding its structure and habits are based upon his observations. I think, therefore, I cannot do better than name the genus of which it will form the type after him.*

The creature was found in swarms among the algæ coating the shells of a *Patella* and of a *Littorina* which had long inhabited a marine vivarium. I had the opportunity of examining its structure when visiting my friend during the past autumn, and the following paper must be regarded as an account of Mr. Dyster's work, with some additions of my own.

Dysteria armata (Pl. VII, fig. 13,) has an oval body, $\frac{1}{350}$th—$\frac{1}{250}$th of an inch long, by $\frac{1}{400}$th—$\frac{1}{430}$th broad, which is not altogether symmetrical—the one side presenting a considerable, evenly rounded convexity, while the other, less prominent, is divided by an angulated, longitudinal ridge (*m*, *k*) into a smaller, dorsal, and a larger, ventral, area. The edges of both lateral surfaces are sharp and thin; dorsally they are separated by a shallow groove (*n*, *o*), but along the ventral line of the body the groove is deep and narrow, and the produced edges of the lateral parietes (*n*, *o*) resemble the valves of a bivalve shell.

The ventral and dorsal grooves pass into one another in front, but posteriorly the lateral edges are united for a short space (*h*). The edge of the left, less convex, side of the body ends anteriorly in an obtuse point (*m*), which corresponds with the anterior termination of the angulated ridge, and does not extend, by any means so far forward, as the edge of the right side, which remains thin, and forms the anterior extremity of the body.

At the anterior extremity the large oral aperture (*a*) is seen, just below the angulated ridge and occupying the bottom of a deep fossa, which here takes the place of the dorsal and ventral grooves. The left wall of this fossa is thickened, and projects inwards so as to form a cushion-like lobe, clothed

* Sticklers for classical terminology may however, if they please, derive the name from δύς and τερας, "a difficult sort of monster," or otherwise, from δύστερις, 'perversely disputatious," on account of the controversies to which the obscure structure of the animal may give rise.

with remarkably long cilia; and these cilia are continued into the oral aperture itself—the posterior ones being large, usually directed transversely to the axis of the body, and having at times much the appearance of vibratile membranes.

The bottom of the oral fossa is strengthened by a curious curved rod (*l*), which terminates superiorly in a bifid tooth, while inferiorly it appears to become lost in the wall of the fossa.

But there is a much more prominent and easily distinguishable apparatus of hard parts situated on the opposite or ventral side of the mouth, and extending thence through two thirds of the length of the body (*b*, *c*). It consists of two portions—an anterior, somewhat rounded mass, in apposition with a much elongated, styliform, posterior portion.

It is very difficult to assure oneself of the precise structure of the anterior portion (*f*), but it would seem to be a deep ring, composed of three pieces—two supero-lateral and mutually corresponding (*q*, fig. 14), united with a third, inferior, azygos portion (*p*). The latter is somewhat triangular, with a broad base and rounded obtuse apex; the latter being directed forwards and immediately underlying the oral aperture, while the former is turned backwards, and unites with the two supero-lateral pieces. Each of these is concave internally and convex externally, so as to form a segment of a circle, and presents a clear median space, the optical expression of either a perforation or of a much thinned spot.

The anterior edge of each supero-lateral piece is nearly straight, but the posterior is convex, and it is by this edge that it articulates with or is apposed to, the anterior extremity of the posterior division of the apparatus. Viewed laterally this posterior portion appears to consist of two styles, which are somewhat like nails in shape; their anterior extremities being truncated so as to present a sort of nail-head, while the posterior extremity seems to take to a fine point. Rather in front of the middle of its inferior edge each style seems to give off a short process downwards (*s*), and this process is, in botanical language, decurrent upon the style. Careful examination of the dorsal or ventral aspect of these parts shows that the decurrent process is in fact only the expression of a delicate membrane, which is bent so as to have a ventral convexity, and connects together the two styles (fig. 15). It might be said, therefore, that the posterior part of the apparatus is a triangular membrane, deeply excavated in front, bent so as to be convex downwards, and having its margins thickened and produced into styliform enlargements. This curious piece of mechanism is directed upwards and back-

wards, and terminates in the substance of the body without any apparent connection with other parts.

The whole apparatus is moveable. The posterior portion is pushed against the anterior, and the heads of the styles come into contact with the posterior convex edges of the supero-lateral pieces, and push them forwards; the posterior portion is then retracted, and the whole apparatus returns to its previous arrangement.

In one *Dysteria*, which had swallowed a filament of *Oscillatoria*, so long, that the one extremity projected from the mouth, when the other was as far back in the body as it could go, these movements took place as many as twenty times in a minute.

Mr. Dyster further informs me that, in one of these animals which he saw feed, the frond of *Oscillatoria* was rather "swum upon" than seized, ingestion being accomplished by a smooth gliding motion, apparently without displacement of the styles; but that when the act was completed the styles "gave a kind of snap and moved slightly forwards."

Mr. Dyster is inclined to think that the *Oscillatoria* passed *through* the anterior ring-like portion of the apparatus. I have not seen the animal feed, but on structural grounds I should rather have been inclined to place the oral aperture at (*a*, fig. 13,) and to suppose that the food would pass *above* the anterior ring. The apparatus is destroyed by caustic potash, but remains unaltered on the addition of acetic acid; it is therefore, probably, entirely composed of animal matter.

Immediately above the annular portion of the apparatus, there is invariably present a remarkable amethyst-coloured globule (*t*), apparently composed of a homogeneous fluid. It has on an average a diameter of $\frac{1}{2000}$ inch, and it is entirely lodged in the more convex portion of the body.* In many specimens no other colouring matter than this can be detected, but in some, minute granules ($\frac{1}{7500}$ inch) of a similar colour are scattered through the body. What connection these have with the large constant globule is not clear, since, although the dimensions of the latter vary from the size given above to one fourth or less, no relation could be observed between this diminution and the presence of the granules in other parts of the body.

Behind the amethystine globule the substance of the body has the appearance, common to the Infusoria generally, of a

* In one or two specimens a minute amethystine globule, not more than one sixth the diameter of the large one, was visible immediately below and behind it. Acetic acid destroys the colouring matter.

mass of "sarcode," in which the ingested matters are imbedded, and no clear evidence could be obtained of the existence of any digestive cavity with distinct walls.

A little behind the middle of the body, and towards its ventral edge, there is a clear spheroidal "contractile space" (*d*), which varies a good deal in size. One measured $\frac{1}{1300}$th of an inch in diameter, and became entirely obliterated in the contracted state.

The contractions are not rhythmical, but take place irregularly. On the approach of death the space becomes irregularly and enormously enlarged, until it occupies perhaps a third of the whole contents of the body.

Immediately beyond the contractile space there is a curious oval body (*e*), having its long axis ($\frac{1}{3000}$ in.) directed upwards, and containing a comparatively small central cavity, so that it appears like a thick-walled sac.

Indications strongly suggestive of an inferior opening were sometimes observed in this body, but no demonstrative evidence of the existence of any such aperture could be obtained.

The walls of the ventral groove are provided with long and powerful cilia, a remarkably strong one being attached behind the base of the "appendage," and by their means the animal, when free, is propelled at no very rapid rate through the water. Its more usual habit, however, is to remain fixed by means of the peculiar appendage (*f*), and then the cilia act merely in creating currents, by which nutritive matters are brought towards the mouth.

The appendage referred to is attached to the surface of the body, rather towards the convex side, at the bottom of the ventral groove, and is distant about one fifth of the whole length from the posterior extremity. It is $\frac{1}{800}$th to $\frac{1}{1000}$th of an inch in length, and is not altogether unlike a boot, with a very pointed toe, in shape; and the toe appears to be viscid at its extremity, so as readily to adhere to any foreign object. The appendage then forms a pivot on which the whole body turns about, and this appears to be the habitual and favorite position of the *Dysteria*.

Internally, the appendage contains a canal (*g*), wider above than below, and apparently blind at each extremity.

No "nucleus" could be found, though carefully sought for with the aid of acetic acid.

The occurrence of transverse fission was noticed very distinctly in one case; but it is remarkable that, notwithstanding the great number of specimens which were observed, no other instance of this mode of multiplication came under

the notice of Mr. Dyster or myself. It would appear that the "apparatus" disappears, and is reproduced during fission, for in the single case observed, mere rudiments of it were to be seen in each half of the strongly constricted mass.

Dysteria has not hitherto been observed to become encysted, although this condition has been carefully sought for.

There can, I imagine, be little doubt as to the true systematic position of *Dysteria*. The absence, in an animal which takes solid nutriment, of an alimentary canal with distinct walls, united with the presence of a contractile vesicle, with the power of transverse fission, and with cilia as locomotive organs, is a combination of characters found only in the *Infusoria*. In this class, again, the existence of a sort of shell or *lorica*, constituted by the structureless outer layer of the body; the presence of a submarginal ciliated groove around a large part of the margins of the body; and the inequality of the two lateral halves, leave no alternative save that of arranging *Dysteria* near or in the *Euplota* of Ehrenberg.

Indeed there is one species figured by Ehrenberg ('Infusions-thierchen,' p. 480, pl. 42, fig. xiv), *Euplotes macrostylus*, found at Wismar, on the Baltic, which, in general aspect, and in the possession of a foot-like appendage, so closely resembles the present form, that were it not for the absence of any allusion to the amethystine globule, or to the "apparatus," I should be strongly inclined to think it identical with *Dysteria*. That an internal armature is not inconsistent with the general plan of the *Euplota*, is shown by *Chlamidodon*, whose apparatus of styles would probably repay re-examination.

Notwithstanding certain analogies which might be shown to exist between the manducatory apparatus of some Rotifera (see, *e. g.*, that of *Furcularia marina*, figured by Mr. Gosse, in his excellent memoir, 'Phil. Trans.,' 1846) and the "apparatus" of *Dysteria*, I see no grounds for regarding the latter as in any way an annectant form between these groups.

On the Origin *of* Greensand, *and its* Formation *in the* Oceans *of the* Present Epoch. By Professor J. W. Bailey, West Point, New York.

(Communicated by the Author.)

As an introduction to the subject of this paper, it is proper to refer to various observations which have been made of facts intimately related to those which I wish to present. That the calcareous shells of the Polythalamia are sometimes replaced by silica, appears to have been first noticed by Ehrenberg, who, in a note translated by Mr. Weaver, and published in the 'L. E. and D. Philosophical Journal' for 1841, vol. xviii, p. 397, says:

"I may here remark that my continued researches on the Polythalamia of the Chalk, have convinced me that very frequently in the earthy coating of flints, which is partly calcareous and partly siliceous, the original calcareous shelled animal forms have exchanged their lime for silex without undergoing any alteration in figure, so that while some are readily dissolved by an acid, others remain insoluble; but in chalk itself, all similar forms are immediately dissolved."

The first notice of *casts* of the cells and soft parts of the Polythalamia was published by myself in the 'American Journal of Science' for 1845, vol. xlviii, where I stated as follows:

"The specimens from Fort Washington presented me with what I believe have never been before noticed, viz., distinct *casts* of Polythalamia. That these minute and perishable shells should, when destroyed by chemical changes, ever leave behind them indestructible memorials of their existence, was scarcely to be expected, yet these casts of Polythalamia are abundant and easily to be recognised in some of the Eocene Marls from Fort Washington." This notice was accompanied by figures of well-defined casts of Polythalamia (l. c., pl. iv, figs. 30, 31).

Dr. Mantell also noticed the occurrence of casts of Polythalamia and their soft parts, preserved in flint and chalk, and communicated an account of them to the Royal Society of London, in May, 1846. In this paper he speaks of the chambers of Polythalamia as being frequently filled with chalk, flint, and *silicate of iron*. ('Phil. Trans.,' 1846, p. 466.) To Ehrenberg, however, appears to be due the credit of first distinctly announcing the connection between the Polythalamia and the formation of Greensand, thus throwing the first light upon the origin of a substance which has long been a puzzle to geologists. In a notice given by this distinguished

observer upon the nature of the matrix of the bones of the Zeuglodon from Alabama (see 'Monats-Bericht,' Berlin, February, 1855), he says:

"That Greensand, in all the numerous relations in which I have as yet examined it, has been recognised as due to the filling up of organic cells, as a formation of stony casts (Steinkernbildung), mostly of Polythalamia, was stated in July of the preceding year." He then refers to the Nummulite Limestone of Traunstein, in Bavaria, as rich in green opal-like casts (Opalsteinkernen) of well-preserved Polythalamian forms, and mentions them as also occurring, but more rarely, in the Glauconite Limestones of France. He then proceeds to give an account of his detection of similar casts in the limestone adhering to the bones of the Zeuglodon from Alabama, and states that this limestone abounds in well-preserved brown, green, and whitish stony casts of recognisable Polythalamia. This limestone is yellowish, and under a lens appears spotted with green. These green spots are the Greensand casts of the Polythalamia, and they often form as much as one third of the mass. By solution in dilute chlorohydric acid, the greensand grains are left, mixed with quartzose sand, and with a light yellowish mud. The latter is easily removed by washing and decantation. The casts thus obtained are so perfect, that not only the genus, but often the species of the Polythalamia, can be recognised. Mingled with these are frequently found spiral, or corkscrew-like bodies, which Ehrenberg considers as casts of the shells of young mollusks.

With reference to the perfection of these casts of the Polythalamia, and the light they throw upon the structure of these minute animals, Ehrenberg remarks:

"The formation of the Greensand consists in a gradual filling up of the interior space of the minute bodies with a green-coloured, opal-like mass, which forms therein as a cast. It is a peculiar species of natural injection, and is often so perfect, that not only the large and coarse cells, but also the very finest canals of the cell walls, and all their connecting tubes are thus petrified, and separately exhibited. By no artificial method can such fine and perfect injections be obtained."

Having repeated the experiments of Ehrenberg upon the Zeuglodon Limestone, I can confirm his statements in every particular, and would only add that, besides the casts of Polythalamia and small spiral mollusks, there is also a considerable number of green, red, and whitish casts of minute anastomosing tubuli, resembling casts of the holes made by burrowing sponges (Cliona) and worms.

In the 'Berlin Monats-Bericht,' for July, 1855, Ehrenberg gives an account of very perfect casts of Nummulites, from Bavaria and from France, showing not only chambers connected by a spiral siphuncle, but also a complicated system of branching vessels. He also gave at the same time an account of a method he had applied for the purpose of colouring certain glass-like casts of Polythalamia, which he had found in white tertiary limestone from Java. This method consists in heating them in a solution of nitrate of iron, by means of which they can be made to assume different shades of yellow and brownish red, still retaining sufficient transparency when mounted in balsam to show the connection of the different parts.

The interesting observations of Ehrenberg which are alluded to above, have led me to examine a number of the cretaceous and tertiary rocks of North America in search of Greensand and other casts of Polythalamia, &c. The following results were obtained:

1st. The yellowish limestone of the cretaceous deposits of New Jersey occurring with *Teredo tibialis*, &c., at Mullica Hill, and near Mount Holly, is very rich in Greensand casts of Polythalamia and of the tubuliform bodies above alluded to.

2d. Cretaceous rocks from Western Texas, for which I am indebted to Major W. H. Emory, of the Mexican Boundary Commission, yielded a considerable number of fine Greensand and other casts of Polythalamia and Tubuli.

3d. Limestone from Selma, Alabama, gave similar results.

4th. Eocene limestone from Drayton Hall, near Charleston, South Carolina, gave abundance of similar casts.

5th. A few good Greensand casts of Polythalamia were found in the residue left on dissolving a specimen of marl from the Artesian Well at Charleston, S.C.; depth 140 feet.

6th. Abundance of organic casts, in Greensand, &c., of Polythalamia, Tubuli, and of the *cavities of Corals*, were found in the specimen of yellowish limestone, adhering to a specimen of *Scutella Lyellii* from the Eocene of North Carolina.

7th. Similar casts of Polythalamia, Tubuli, and of the *cavities of Corals*, and spines of Echinus, were found abundantly in a whitish limestone adhering to a specimen of *Ostrea sellæformis* from the Eocene of South Carolina.

The last two specimens scarcely gave any indications of the presence of Greensand before they were treated with dilute acid, but left an abundant deposit of it when the calcareous

portions were dissolved out. All the above mentioned specimens contained well-preserved and perfect shells of Polythalamia. It appears from the above, that the occurrence of well-defined organic casts, composed of Greensand, is by no means rare in the fossil state.

I come now to the main object of this paper, which is to announce that the formation of precisely similar Greensand and other casts of Polythalamia, Mollusks, and Tubuli, is now going on in the deposits of the present ocean. In an interesting report by Count F. Pourtales, upon some specimens of soundings obtained by the U. S. Coast Survey in the exploration of the Gulf Stream (see 'Report of U. S. Coast Survey,' for 1853, Appendix, p. 83), the sounding, from Lat. 31° 32′, Long. 79° 35′, depth 150 fathoms, is mentioned as "a mixture in about equal proportions of Globigerina and black sand, probably greensand, as it makes a green mark when crushed on paper." Having examined the specimen alluded to by M. Pourtales, besides many others from the Gulf Stream and Gulf of Mexico, for which I am indebted to Prof. A. D. Bache, the Superintendent of the Coast Survey, I have found that not only is Greensand present at the above locality, but at many others, both in the Gulf Stream and Gulf of Mexico, and that this Greensand is often in the form of well-defined casts of Polythalamia, minute Mollusks, and branching Tubuli, and that the same variety of the petrifying material is found as in the fossil casts, some being well-defined Greensand, others reddish, brownish, or almost white. In some cases I have noticed a single cell, of a spiral Polythalamian cast, to be composed of Greensand, while all the others were red or white, or *vice versa*.

The species of Polythalamia whose casts are thus preserved, are easily recognisable as identical with those whose perfectly preserved shells form the chief part of the soundings. That these are of recent species is proved by the facts that some of them still retain their brilliant red colouring, and that they leave distinct remains of their soft parts when treated with dilute acids. It is not to be supposed, therefore, that these casts are of extinct species washed out of ancient submarine deposits. They are now forming in the muds as they are deposited, and we have thus now going on in the present seas a formation of Greensand by processes precisely analogous to those which produced deposits of the same material as long ago as the Silurian epoch. In this connection, it is important to observe that Ehrenberg's observations and my own establish the fact that *other* organic bodies than Polythalamia produce casts of Greensand; and it should also be

stated that many of the grains of Greensand accompanying the well-defined casts are of wholly unrecognisable forms, having merely a rounded, cracked, lobed, or even coprolitic appearance. Certainly many of these masses, which often compose whole strata, were not formed either in the cavities of Polythalamia or Mollusks. The fact, however, being established beyond a doubt, that Greensand does form casts in the cavities of various organic bodies, there is a great probability that all the masses of this substance, however irregular, were formed in connection with organic bodies; and that the chemical changes accompanying the decay of the organic matter have been essentially connected with the deposits in the cavities, of green and red silicates of iron, and of nearly pure silica. It is a curious fact in this connection, that the *siliceous* organisms, such as the Diatomaceæ, Polycistineæ, and Spongiolites, which accompany the Polythalamia in the Gulf Stream, do not appear to have any influence in the formation of casts.

The discovery by Professor Ehrenberg, of the connection between organic bodies and the formation of Greensand, is one of very great interest, and is one of the many instances which he has given to prove the extensive agency of the minutest beings in producing geological changes.

Further Observations *on* Vegetable Growth.

By the Hon. and Rev. Sidney Godolphin Osborne.

It may interest the readers of the 'Journal' to know that further observation has given me a deeper insight into the structure of the wheat plant in the earliest stage of its growth. I find there is a "circulation" in every one of the long suckers put forth from the roots; it may be seen very plainly under a power of 800. Although I can trace it with ease along the outer edge of each sucker, running from the root towards the blunt point, I cannot trace any current returning towards the root.

In the case of the spiral fibre in the early plumule, I now find it to have in every case its own investment; that, in fact, it is within a tube of very thin cellular texture. By careful management of the light, lines running vertically the whole length of this tube can be seen; I presume these to be the outlines of a fine wall of cells, of which this tube is formed. The coils of fibre, if attached at all to this tube, are only partially so, as I have succeeded by pressure in extending a

coil without disturbing in any way the tube itself. That they exercise considerable pressure upon the tube, at the points where the coils are close, is quite evident by the extension that they there clearly give to it.

Although I have failed in every endeavour to make out the existence of spiral fibre in the grain of wheat, in other vegetables I can clearly trace it, but only in the embryo seed. A very fine section of a young "vegetable marrow," made so as to pass through the embryo seeds, will show coils of spiral fibre passing from the flesh of the fruit into these seeds; and at the narrow extremities of each seed, it can with ease be made out with a power of 500. The embryo seeds are, in fact, connected with the fruit by a small bundle of this fibre. I believe this to be the case with the wheat, and I have little doubt but that a careful dissection of the attachment of each grain in an ear of such corn, made at the time when the grains are just assuming their form, would prove it.

I have been much interested by a continued close study of the "double ovate" vesicles to be ever found imbedded in the plasm *in* which, if not *from* which, the root cells of the wheat root are formed. I have the strongest impression that these are the earliest organisms of plant life, so far, at least, as the roots of plants are concerned. I will not now hazard the publication of all the extraordinary features I have observed in them; one, however, not the least extraordinary, I will mention. I have now preparations of the formative matter of the wheat root, sealed hermetically more than six months since, and floating in "Thwaites's fluid," the double ovate cells of which are in as active a motion at this time as they were the day I put them up from the growing root. By the use of the twelfth power B eye-piece, and good light, they may be seen to have taken up the pigment in which I have grown the plants; indeed, I am now satisfied it is by their close aggregation within the cells of the roots, that I get the rich colour I do, when the plants are grown in coloured *media*. The divisions of my micrometer eye-piece, with the twelfth power, as given me by Mr. Ross, are $\frac{1}{13500}$ (0·000074). One of these active vesicles will occupy rather more than one of these divisions. The movement of these minute bodies is very different from the molecules of gamboge and other substances; I have never seen anything the least resembling it, except in preparations I have made from prepared glasses, exposed for a time to the atmosphere in the early days of summer, when the air is full of spores.

What life it is I know not, but I believe it to be positively *life*.

On Striated Muscular Fibres *in the* Skin *of the* Human Lip. By Dr. Woodham Webb, Lecturer on Histology at the Grosvenor Place School of Medicine, London. (Plate VII, fig. 16.)

Kölliker, Eylandt, Henle, and Lister have accurately enough described the unstriped muscular fibres connected with the hair-sheaths and sebaceous glands in the scalp and other parts of the skin. These are now well known by the significant name of *Arrectores pili,* given to them by Eylandt. Huxley has also figured branched muscular fibres of the striated kind attached to the vibrissæ of the rat. But no notice has yet been published of a series of striped fibres and bundles of fibres existing in the human lip, and having there corresponding relations and actions. Such, however, may be found proceeding, in numerous small groups, from the orbicularis oris, and passing outwards through the corium. These minute bundles of muscular fibre are thrown off from the outer layer of the orbicularis oris, and are to be traced in compact masses to the base of the hair-sheaths and sebaceous glands. At this point the fibres separate, spread themselves over the surface of the gland, form more or less close attachments to the membrane investing the glandular structure, and appear to interlace with each other. Above the gland, they are reduced to the condition of independent fibres, diverge somewhat widely, so that those from adjoining glands cross each other, and continuing outwards, gradually lose their striated character; becoming at the same time much smaller. They ultimately merge into the connective tissue which forms the basement membrane of the papillæ, in the same manner as the muscular fibre of the tongue is described by Dr. Hyde Salter to pass directly into the bundles of the submucous connective tissue. It has not been observed that any of these ultimate fibres are branched; nor are there any traces of the coexistence of non-striated muscular appendages. The points of attachment below, around, and above the glands and hair-sheaths, sufficiently explain the action of these muscles; the nature of the part in which they are situated accounts for the deviation in the arrangement of the respective structures from that prevailing elsewhere; and it may easily be understood how, though so small individually, these muscles, by their conjoint action, assist in determining the expression of the parts about the mouth.

TRANSLATIONS.

ALGARUM UNICELLULARIUM GENERA *nova et minus cognita, præmissis* OBSERVATIONIBUS *de* ALGIS UNICELLULARIBUS *in genere.*

New and less known Genera of UNICELLULAR ALGÆ, *preceded by* OBSERVATIONS *respecting* UNICELLULAR ALGÆ *in general.* By ALEX. BRAUN. (Lipsiæ, 1855; with six Plates.)

Continued from No. XVII, p. 16.

IN one respect only does the question appear to require more strict definition, a careful distinction should be made between *Algæ* which are unicellular only in the looser sense of the term, and those which have a more direct title to the name; for several genera of *Algæ* (among the *Palmellaceæ*, *Desmidiaceæ*, and *Diatomaceæ*), though formed indeed of isolated cells, or of cells loosely connected merely by a gelatinous matter, nevertheless exhibit a vegetative division of the cells, by means of which they are multiplied through a more or less extended series of generations, until the cycle of vegetation terminates in the production of *gonidia* or of spores. In these genera, therefore, as in the multicellular *Algæ*, divers generations of cells are to be distinguished:—1, *ordinal*,* which by their conjunction constitute the vegetating individual, either continuous, or broken up and dissected into parts (individuals of a lower order); and 2, *cardinal*,† by which fructification is accomplished, and the transition to a new series of ordinal cells effected. It is obvious, therefore, that *Algæ* of this kind, since they really pass through a multicellular vital cycle, and are unicellular only in appearance (pseudo-unicellular), must, in a biological sense, be regarded as multicellular; whence it is readily seen that they cannot be separated from other multicellular *Algæ* formed of contiguous cells, by any strict line of demarcation either morphological‡ or systematic.§ Unicellular *Algæ*, in

* 'Reihengenerationen,' Näg. einz. Algen, p. 25.

† 'Uebergangsgeneration,' ibid. (Schlussgeneration).

‡ Compare the *Diatomaceæ* and solitary *Desmidiaceæ* with the catenated forms: *Tetraspora* with the *Ulvæ*, through *T. bullosa*, which is referred by Thuret to the *Ulvaceæ*, under the name of *Monotrema*; compare also *Hormospora* with *Ulotriche*, *Stichococcus* with *Hormidium*, *Synechococcus* with *Oscillaria*, &c.

§ The *Diatomaceæ* and *Desmidiaceæ*, placed, according to Nägeli's classi-

the wider sense of the term, would be distinguished by a more essential character, if with them were conjoined all those which exhibit similar generations of cells, so that a specific idea is equally represented* in each cell, either free or united with others. But such a character, if the matter be more closely scrutinised, is scarcely anywhere really exhibited among *Algæ* endowed with the property of vegetative division, since, at any rate, the cells of the cardinal generation differ from the rest physiologically and sometimes also morphologically; and in the cells themselves of the ordinal generations some differences, which can hardly be regarded as fortuitous, and chiefly relating to magnitude,† may be observed. It is obvious, therefore, that in all these instances a specific idea can only be really completed by a certain cycle of cells.

The more strictly unicellular *Algæ*, however, present conditions altogether different, their entire and undivided vital cycle being completed by the continuous evolution of a single cell. In them there is no division of the cell throughout the whole course of vegetation, nor any multiplication and diversity of generations, since the same cell successively assumes the functions of *thallus* and of organ of fructification (of goniocyst or sporo-cyst, *vulg.* "sporangium"). But among these also some diversity is presented, by which the forms, in the strictest sense of the term, unicellular, are separated from those which, in a certain sense, hold an ambiguous place; for the unicellular *Algæ* differ with respect to the generation of the *gonidia*, which in some is effected by the direct separation and transformation of the cell-contents,‡ and in others is preceded by a previous repeated act of division.§ That the former are unicellular, in the strictest sense of the term, no one will doubt, since they exhibit no series of generations within the vital cycle; but the latter, which, after the unicellular state of vegetation, pass through intermediate *quasi* multicellular states, in order to complete their fructification, might be regarded as multicellular *Algæ*, if indeed the term cells could properly be applied to those transitory generations, composed merely of portions of the plasma of the primary

fication, among the unicellular *Algæ*, are very closely allied to the *Zygnemaceæ* among the multicellular *Algæ*; and in the same way the *Chroococcaceæ* are intimately related to the *Nostochineæ* (in the wider sense).

* Nägeli, einz. Alg., pp. 2 and 3.

† Compare the *Diatomaceæ* and *Desmidiaceæ* (especially the *Closteria*), as well as the *Glæocapsæ*, *Tetrasporæ*, &c.

‡ As in *Hydrocytium*, *Codiolum*, *Chytridium*, *Bryopsis*, *Botrydium*, and *Hydrodictyon*.

§ In *Cystococcus*, *Characium*, and *Pediastrum*.

cell (primordial or naked cells as they are termed), scarcely separated by any proper membranes, and presenting no indication of vegetative evolution. However this may be, it is clear that these transitory generations perform the functions of imperfect *gonidia*, destined to undergo a second division, on which account, and from their close similarity in habit* and other characters, this ambiguous section should perhaps be referred to the unicellular type, though it cannot be denied that a connecting link with the multicellular *Algæ* (pseudo-unicellular) is presented in it.

From the *unicellular Algæ*, besides the *pseudo-unicellular*, are also to be distinguished those which are typically *bicellular*, producing two heterogeneous cells, one of which constitutes a *thallus*, the other a *goniocytium* or a *sporocytium*. These plants have, it is true, a unicellular thallus, but have also *gonocytia* or *sporocytia* distinct from and exclusive of the *thallus*. The simplest state, such as is exhibited in extremely depauperate specimens of *Vaucheria*, represents a simple vegetating cell, terminated above in a single *goniocytium*. But generally a more complex bicellular type is exhibited in those forms, the vegetating cell branching in various ways, and consequently supporting several fructification-cells, which differ in different cases, according as they constitute *gonidia* and *spores*. In *Codium* but one mode of fructification (that of *gonidia*, within a *goniocytium*) is known, whilst in *Vaucheria*, *Achlya*, and *Saprolegnia*, a double, or even threefold kind of fructification may be observed.†

The author is not acquainted with a *tricellular* type of evolution among the true *Algæ*; but in the mycetoid plants analogous to *Algæ*,‡ this mode of evolution is manifested very distinctly in *Pilobolus*,§ which is truly a tricellular *fungillus* whose thallus is divided into two cells—a root, as it were, and a stem, which supports a third cell (*sporocytium*).

* Compare, for instance, *Characium* with *Hydrocytium*, *Pediastrum* with *Hydrodictyon*.

† The corniculate ramules of *Vaucheria* which accompany the lateral sporocytia containing hypnospores, from the observations of Karsten (Bot. Zeit., 1852, p. 86), which, however, should be received with caution, the author scarcely doubts to be *goniocytia*, emitting lesser zoogonidia (microgonidia). [On this point *vide* Pringsheim's observations, given in the 'Quarterly Journal of Microscopical Science,' vol. iv.] Hence it will be perceived that *Vaucheria* presents a triple apparatus of fructification.

‡ The mucorine *Fungi*, amongst which *Pilobolus* belongs, together with the closely allied *Saprolegniæ* (including *Leptomitus lacteus*), wholly agree with the *Vaucheriaceæ* (and with the *Codieæ*) in their usually unicellular *thallus*, and the endogenous formation of their spores.

§ Cohn, in Nov. Acta Nat. Curios., 23, 1, p. 492, tab. 51.

But to return to the true unicellular *Algæ*. The number of genera belonging to this class at present known is small, but amongst them great diversity exists. The greatest care is requisite in their determination as independent organisms; nor should this be decided, unless every stage of their evolution from beginning to end is known. Especially must we be careful not to regard the young state of *Algæ* of a higher order, or depauperate generations (*pauperculæ*), as unicellular genera.* Nor, on the other hand, should less caution be observed not to confound associations of unicellular *Algæ* with the multicellular. For in several genera of the latter class the closest and most regular associations of distinct individuals, which at first are sometimes freely motile, are met with. These forms are in the highest degree fallacious, presenting as they do a false resemblance to a cellular texture. They are well worthy of more particular attention, and a comparison of them with the families or colonies of the pseudo-unicellular *Algæ* may not be considered superfluous. These compound bodies, however, in *Algæ*, more or less properly speaking unicellular, formed by the association of cells, are so well treated of by Nägeli ('Einz. Algen.,' p. 24), as regards their origin, composition, and diversity of form, that the author has scarcely anything to add beyond certain distinctions, belonging more especially to unicellular *Algæ* in the stricter sense of the term. For the associations of *Algæ*, less properly so termed, or of the pseudo-unicellular class, are always formed by the vegetative multiplication of cells; and those of the really unicellular by true propagation: the former, therefore, merely represent individuals divided into more or less independent and loosely coherent parts, and cannot be distinguished by any strict definition from a continuous thallus; whilst the latter are really constituted of several individuals distinct from the first. The associations of pseudo-unicellular *Algæ* are evolved from a single cell (spore or *gonidium*) by successive multiplication, the number of cells gradually increasing through a more or less determinate series of generations; whilst the associations of the more strictly unicellular *Algæ*, on the contrary, are constituted of several cells (*gonidia*), distinct *ab origine*, the number of cells never increasing, owing to the absence of any vegetative division; the former, in fact, constitute *families* of cells, pro-

* *Pauperculæ* of this kind, that is to say, individuals normally depauperate, and curiously simulating 1-2 cellular parasitic plants, are produced in some species of *Œdogonium*, as well as in *Bulbochæte*, from microgonidia. *Vide* Braun, 'Rejuvenescence,' p. 151; Ant. de Bary, in 'Mus. Sekenb.,' 1854, pp. 63, 87, t. iii and iv.

ducing, from a single mother-cell, secondary, tertiary, and quaternary, &c., cells up to a certain stage; whilst the latter, formed, as it were, from sister-cells, and never producing any offspring admitted into the society, might rather be termed *cænobia*. One exception to this rule only is known to the author, presented in *Sciadium*, a strictly unicellular plant, but which is nevertheless evolved into a true family, formed, however, not by vegetative multiplication, but by way of propagation.

The author, therefore, from the foregoing considerations, would classify the associations of the lower *Algæ*, according to their principal differences, in the following manner:

A. An association evolved by successive generations of cells from a single mother-cell (spore, *gonidium*): FAMILIA;

a. Cells arising by vegetative division (more or less distinct, but retained in connection by means of the parent membrane): the family representing an individual biologically single (a thallus broken up):

α. Order of cells immutable: *Hormospora! Palmodactylon! Merismopædia! Tetraspora, Glæocapsa, Glæocystis;*

β. Order mutable: *Nephrocytium, Glæothece, Aphanothece, Apiocystis.*

b. Cells arising by true propagation: FAMILIA CÆNOBIOTICA, composed of individuals really distinct: *Sciadium.*

B. Association constituted of several cells (*gonidia*) originally distinct: CÆNOBIUM;

a. Constituted of zoogonidia, which become united after a motile stage, and grow into immotile cells;

α. Order immutable: *Hydrodictyon;*

β. Order mutable: *Pediastrum.*

b. Of immotile gonidia, which grow into immotile cells;

α. Order immutable: *Scenedesmus, Sorastrum;*

β. Order mutable: *Cœlestrum?*

c. Of immotile gonidia, which change into vibratory cells;

α. Order immutable: *Gonium, Stephanosphæra, Synaphia;*

β. Order mutable: *Pandorina.*

To this arrangement another is subjoined, in which a synoptical comparative view is given of the differences exhibited in the lower *Algæ*, derived from the *simple* or *multiple* generation of cells described above:

A. MONOCYTIDEÆ, or Unicellulares, exhibiting a unicellular vital cycle:

a. True, or unicellular in the strictest sense of the term; no transitional generations of *gonidia;*

α. *Eremobiæ*, growing with a solitary cell: *Protococcus*, Näg., *Hydrocytium, Codiolum, Ophiocytium, Polyedrium?* (*Chytridium*);

β. *Cœnobiæ*, the unicellular individuals associated into a *cœnobium* (pseudo-multicellular) : *Hydrodictyon ;*

γ. *Synoicobiæ*, associated into families (pseudo-multicellular): *Sciadium:*

b. Ambiguous, *i. e.* forming *gonidia* by means of transitional generations, and indicating the transition to the multicellular *Algæ :*

α. *Eremobiæ*, as above : *Cystococcus, Charucium ;*

β. *Cœnobiæ*, as above: *Pediastrum, Scenedesmus, Gonium, Pandorina, Stephanosphæra, Synaphia.*

B. Oligocytideæ, the vital cycle limited to few cells; cells, two or three, heterogeneous.

a. Bicellular: *Codium, Vaucheria* (*Saprolegnia, Achlya*) *;*

b. Tricellular: *Pilobolus.*

C. Polycytideæ, or multicellular, the vital cycle including many cells:

a. *Homœocytideæ*, cells (the vegetative at any rate) subsimilar:

α. *Schizocytideæ*, cells more or less separate from each other (pseudo-unicellular):

* *Choristobiæ*, cells quite separate: *Navicula, Closterium, Pleurococcus, Chroococcus.*

** *Synœcobiæ*, cells loosely connected by gelatinous envelopes, associated into families : *Schizonema, Hormospora, Palmodactylon, Palmella, Hydrurus.*

β. *Synechocytideæ*, cells contiguous (the family of cells becoming a continuous *thallus*) : *Himantidium, Desmidium, Spirogyra, Oscillaria.*

b. *Neterocytideæ*, cells obviously differing in nature: *Nostoc, Cylindrosporum, Rivularia, Œdogonium, Bulbochæte,* &c.

In this classification, the first section (A) alone contains *Algæ*, in the author's opinion, truly unicellular, although *Algæ*, unicellular according to Nägeli's definition, are included in sections A, B, and C, *a*, α and β (in part). It need scarcely be remarked, however, that all the sections in this classification taken from single characters are merely artificial, and do not correspond with families founded upon a real and intimate affinity. Nor, indeed, would it seem that all unicellular *Algæ*, in the stricter sense of the term, are of necessity so closely allied as to be included in a single and peculiar tribe; points, the discussion of which is reserved till the description of each genus is given.

Some observations remain to be made respecting the terminology of the *Algæ*. The vegetative substance of the *Algæ*, as regards the varieties of forms, has received various appellations, but by Kützing it has been termed in general *phycoma*, for which the author would substitute *phytoma*, a

term extending to the vegetative substance of all plants. Were the term *phycoma* to be admitted, the *phytomata* of other classes of plants would also require to be designated by special names, *e.g.*, for the Fungi *mycoma*, for the Mosses *bryoma*, for the Ferns *pteridoma*, would have to be adopted, which the author regards as superfluous, since only two kinds of *phytomata* need be distinguished on morphological grounds, viz., *phytoma cormodes* for the phanerogamous and higher cryptogamous plants, and *phytoma thallodes* for the lower cryptogams. The author, therefore, thinks it would be right to employ the term *thallus* to designate the vegetative body of both the Lichens and Fungi.

The cell is by him expressed by the Greek term *cytis*, which is also employed by others, whence the derivatives *cytioblastus, cytioplasma, cytioderma.*

(*To be continued.*)

Remarks on Dr. Stein's Doctrine *respecting the* Acineta-Forms. By Dr. H. Cienkowski.

(From the 'Bulletin de la Classe Physico-Mathematique de l'Academie Imperiale des Sciences de St. Pétersbourg,' January, 1855.)

Stein's observations respecting the Infusoria have justly excited great astonishment among the micrographers. The wonderful phenomena of "Alternation of Generations" have been represented by this observer as occurring more extensively among the Protozoa than perhaps in any other class of animals. The *Vorticellina*, in consequence of a process of "encysting," are transformed into *Acinetæ*, and these again into Vorticellæ, by means of internal motile embryos, which are emitted from them.

In order to arrive at an independent judgment with respect to these Acineta-forms, I have examined the following species: *Podophyra fixa*, Ehr., the Acineta connected with it, and *Vorticella microstoma*, Ehr. Now, if the doctrine be substantial and not merely hypothetical, two important statements should be borne out by facts; viz., the transition of the *Vorticellæ* into *Podophryæ*, and, secondly, the transformation of the offspring of the *Podophryæ* into *Vorticellæ*.

Stein arrived at the former conclusion by comparing *Podophryæ* remaining at an early stage of development with metamorphosed *Vorticella-cysts*. Among *Podophryæ* of the

common form, others not unfrequently presented themselves whose spherical body was enclosed in a usually wide case, which was produced into a hollow funnel-shaped peduncle. This case presented equidistant annular constrictions, alternating with acute, parallel, angular ridges. Most of the individuals in this condition were unarmed; but occasionally Stein noticed them to be furnished with numerous capitate tentacles.

On the other hand, Stein observed that, in the older cysts of *Vorticella microstoma*, the enclosed parent-vesicle had undergone a change. Its naturally smooth, even surface, almost everywhere closely fitted to the cavity of the cyst, was in many places separated from the cyst-wall and depressed towards the interior, in deep sinuosities, whilst in other parts the parent-cyst was protruded into cæca—which from their considerable size impinged with such force against the wall of the cyst, that it appeared as if they were endeavouring to rupture it.

These metamorphosed stages of the Vorticella-cysts, as Stein further remarks, appeared to merge imperceptibly into the above-described undeveloped conditions of the *Podophryæ;* it being assumed that the vesicular dilatations of the parent-vesicle within the Vorticella-cysts were only the commencement of a still greater enlargement of the parent-vesicle; whose forcible extension ultimately ruptured the walls of the containing cyst. In cases where the cyst is distended uniformly by the parent-vesicle contained within it—which would happen when the cyst is free all round—the Vorticella-cyst with its contents would of course be transformed into an *Actinophrys;* but when this uniform distension in all directions is in any way prevented, in consequence of the cyst being attached to some solid substance, all the Vorticella-cysts would be transformed into *Podophryæ*, supported on longer or shorter peduncles.*

These are the real facts upon which Stein supports the doctrine of the transformation of Vorticella-cysts into *Podophryæ*. For the circumstance that in infusions containing cysts of *Vorticella microstoma, Podophryæ* afterwards made their appearance, can certainly not be regarded as decisive in favour of the notion which would view the two Infusoria as standing in any connection of development.

With respect to the second proposition concerning the transformation of the motile embryo into a *Vorticella*, Stein admits that he has not directly observed it, as in spite of

* Stein, 'Infusionsthiere.,' p. 145.

every endeavour he was never able to keep the embryo long enough in the field of view. "The only proof, therefore, would exist in the extraordinary resemblance of the motile embryo, in form, ciliation and movement, to the detached gemmated embryo of *Vorticella microstoma*." *

My own researches on *Podophrya* have led to the following results:

Podophrya fixa, Ehr., occurred in great abundance in an infusion containing multitudes of *Stylonychia mytilus* and *S. pustulata*. The spherical body was furnished on all sides with capitate retractile rays, and fixed on a peduncle, or free. The peduncle was enlarged on the free extremities, straight or slightly curved, and it was as long or longer than the body.

The contents of the body were in most instances more or less opaque, coarsely granular, and enclosed a round contractile space, and an oval, straight or curved nucleus; which could be perceived only in those individuals in which the contents were fluid. I could not perceive any membrane surrounding the body. Nearly every specimen of the *Stylonychiæ* was infested with one or several *Podophryæ*. In proportion as the body of the *Stylonychia* diminished in size and broke up, did the colour of the *Podophryæ* become deeper and deeper, and their size increase. In many individuals, fed in this way, a shallow circular depression might be seen surrounding the body equatorially (fig. 1). In about half an hour this annular constriction had advanced to complete transverse fission (pl. VII, figs. 2, 3). About ten minutes afterwards the upper segment had assumed an elongated form, was more cylindrical, a little indented in the middle, and rounded at each end; and at the extremities slight oscillations to the right and left could be perceived (fig. 3). A transverse and, frequently, curved nucleus was visible in the fluid contents, and a lateral contractile space could be clearly distinguished in the upper parts. The vibrations increased in frequency and force until the segment became wholly detached and escaped. During the process of division both segments were furnished with tentacles; but when the oscillations of the cylindrical portion commenced, very fine and short cilia might be seen, though with difficulty, vibrating on the free end, the tentacles at the same time being retracted, and remaining visible only on the posterior segment. I now followed uninterruptedly the movements of the liberated segments. They moved for the

* Stein, l. c., pp. 167, 168.

most part in curved lines, in the course of which the motile segment appeared to seek the illuminated side of the drop of water. Cilia could not be perceived over the whole surface (fig. 3′). The contractile space during the movements was always in front. The motions were rapid, but still such as to allow of their being followed with a magnifying power of 370 diam. After waiting patiently for twenty minutes I saw the motion cease, and at the same time short tentacles made their appearance, which were protruded more and more, and in a few minutes afterwards the segment regained the spherical form; thus, after moving about freely for a time, it was again transformed into a *Podophrya*.

This process of division was witnessed by other observers. It takes place more especially when sufficient nutriment is supplied, by numerous *Stylonychiæ* to the *Podophryæ*. The *Podophrya* does not always divide into two equal halves—the segments are more frequently unequal. After repeated division the specimens always become more transparent.

If *Podophryæ* are allowed to remain for several days upon the object-glass, and care is taken not to let the water dry up, every stage towards the quiescent condition—that is to say, towards the "encysting"—may be followed.

In *Podophrya*, this process takes place in the following manner: On the surface of the body a gelatinous mucous layer appears to be secreted, through which the tentacles pass (fig. 4). The tentacles disappear in the neighbourhood of the peduncle, and the gelatinous layer in this situation hardens into a loose, transversely plicated membrane; whilst at the upper end it is still soft, and the tentacles clearly visible (fig. 5). Ultimately these also are retracted, and the entire body of the *Podophrya* is enveloped in a wide, loose membrane; the plications are caused by parallel, annular constrictions, placed at equal distances apart and separated by circular, angular or rounded ridges; these plications are in a plane perpendicular to the peduncle. At the summit of the *Podophrya*, and often also at the base, the membrane presents deep depressions (figs. 7, 6); the enclosed body of the *Podophrya* acquires on its surface a sharply defined smooth membrane; whilst the contents of the body become somewhat opaque, enclosing a round clear space (figs. 6, 7, 8). The Podophrya-cyst thus formed is supported by a peduncle, which is widened at the base. In many instances in which the membrane was not plicated, but loosely enclosed the *Podophrya* like a sac, I noticed that the peduncle of the cyst was continued uninterruptedly into the membrane, of which

consequently it must be regarded as a protrusion, and that it had no connection whatever with the original slender peduncle of the *Podophrya* itself. In fact, I noticed cysts in which this original slender peduncle was appended to the saccular envelope (fig. 8). I am unable, therefore, to adopt Stein's view that the *Podophryæ* are enclosed in a membrane, of which the slender peduncle is simply a tubular protrusion.* This is true only with respect to the short peduncle of the encysted *Podophryæ*.

What afterwards becomes of the cysts I have been unable, in spite of observations continued for months, to determine.†

Comparison of my fig. 5 with that of Stein (l. c., pl. iv, fig. 31), will remove all doubt as to their representing identical forms. These forms, as has been mentioned, are regarded by Stein as transitional stages from the Vorticella-cysts into *Podophryæ*. I have traced their derivation, step by step, in the same specimens, *from Podophryæ;* they are, most certainly, *not* metamorphosed Vorticella-cysts, but the commencement of the encysting of a *Podophrya,*—*Podophryæ*‡ are not formed out of them, but, on the contrary, from the latter arise the forms above described, which Stein looks upon as *Podophryæ* remaining at an early stage of development. The metamorphosed contents of older Vorticella-cysts, regarded by Stein as the first commencement of the formation of a *Podophrya,* indicate, according to what I have seen in other infusorial cysts,§ and to what Stein himself states, with regard to *Vorticella microstoma,* the commencement of the breaking up of the entire contents into numerous smaller "swarm"-cells.

I now proceed to show the relations of the motile embryo.

In a watch-glass in which I kept a great many specimens of *Hydra fusca* in water, numerous *Acinetæ* occurred in the mucoid deposit, which could in no respect be distinguished from those represented in Stein's figures 28, 38, 41, pl. iv. They were oval, spherical, or two- to four-lobed bodies; in the spherical forms the long slender tentacles were usually grouped in two opposite bundles; in the lobed forms often

* Stein, l. c., p. 144.

† The Podophrya-cysts have been described by Dr. Weisse under the name of *Orcula trochus.* 'Bull. de la Classe phys. math.,' t. v, No. 15; t. vi, No. 23.

‡ Sic in origine. [*Vorticellæ*?]

§ I have observed the formation of several cells in the cysts in *Stylonychia pustulata, S. mytilus,* and *Nassula ambigua.* In the latter, these cells constitute protrusions, and their entire contents break up into numerous, motile, monadiform corpuscles.

seated upon wart-like eminences. The contents were clear, fluid or grumous, enclosing from one to four contractile spaces. Most of these *Acinetæ* were without peduncles, and had no limitary membrane, although numerous specimens might be seen with a short peduncle and imbedded in a mucoid thick envelope; and this was especially observed when the *Acinetæ* had lived for about a week on the object-glass (figs. 9, 10). Although numerous points of relation exist between these Acineta-forms and *Podophrya fixa*, Ehr., I am, nevertheless, unable to determine whether they should be regarded as identical, or, with Stein, whether *Podophrya* and *Actinophrys* should be considered as the extreme links in the morphological cycle of one and the same species.* The peduncle of an *Acineta* is a tubular elongation of the enveloping membrane; whilst, in the membraneless *Podophrya*, it is an independent formation. When the *Podophryæ* are left in water for a few days upon the object-glass, they form the very characteristic pedunculate cysts, but under the same conditions I have never been able to follow the Acineta-forms now in question to the formation of cysts; the former multiply by division—whilst, in the *Acinetæ*, I have never noticed the occurrence of that process. What Stein describes as *Actinophrys* is really a non-pedunculate *Acineta*; the *Actinophryæ* have no tentacles, but *setæ*, though perhaps occasionally some of these setæ are capitate. In almost every specimen of the *Acinetæ* in question, might be seen rotating a round or oval embryo, of various size and position, with one or two contractile spaces (fig. 9). This embryo slowly approached the wall of the *Acineta*, caused it to protrude a little outwards, and, after remaining for a short time quiescent, it slowly made its way through the wall, and quitted the parent site with the rapidity of lightning, when it had freed about half of itself. This rapidity was so great that the course could not be traced with a magnifying power of 170 diam. (fig. 10). About five minutes elapsed from the commencement of perceptible motion to the complete liberation of the embryo; and on many occasions I saw two rotating embryos liberated in succession. When the embryo is half out of the parent-cyst, a transverse ring of very fine vibratile cilia may be perceived at a short distance from its summit. I was prevented from further pursuing this observation, which was made in June, and it was not before November that I found the same *Acinetæ*, but in far smaller numbers.

* Stein, l. c., p. 143.

After waiting for a few weeks in vain, I at last noticed individuals containing rotating embryos. But the motion was very slow, and the embryo often reached the surface of the *Acineta* without its being able to make way through it, in which case it perished. The number of rotating embryos gradually increased, and their liberation, although very slow (half to three quarters of an hour), may be frequently witnessed. The half-freed embryo in these cases also moved off with extraordinary rapidity. I determined to follow the embryo in its hasty wanderings, and actually to convince myself of the supposed transformation into a *Vorticella*.

I endeavoured in the first place to retain as many full-grown specimens of *Acineta*, as possible, upon the object-glass, so as not to be interrupted by any deficiency in the number of "motile" embryos. I employed in the inquiry a simple microscope of low power. Having fixed a large *Acineta* containing a rotating embryo, I witnessed the liberation of the latter, and followed it—by moving the object-glass—step by step.

The embryo traversed the drop of water from one side to the other, in divers straight and undulating lines, as quick as lightning. Upon meeting a mass of mucus or the edge of the drop, it bounced back again—repeating the manœuvre on each occasion of the same kind; sometimes, though more rarely, the movement was circular around the margin of the drop.

Judging from what I had noticed in the division of the *Podophryæ*, I expected that the movement would not be of long duration. But after a continuous observation for fully five hours of the active motions of the tiny brilliant point, a determination of blood to the head obliged me to desist.

A fresh drop of the infusion, in which two embryos were in active motion, was observed at intervals of a quarter of an hour. At the end of five hours the rapidity of the movement was notably diminished—it became tremulous, and then perhaps for a time as rapid and energetic as before. I now placed the object under the compound microscope, and continued my observation of the indefatigable embryo for another quarter of an hour; the embryo became stationary—I awaited with drawn breath what would come next: its form from oval became spherical; at the border appeared short, thick, equidistant rays, which after awhile were developed into elongated, capitate tentacles (figs. 11, 12); the contractile space was visible—and I could not longer doubt as to the *Acineta* nature of the creature. This observation was twice repeated.

It can, therefore, no longer be doubted that from the *Acineta-embryo,* after a prolonged motile stage, another *Acineta* is formed. My observations do not, of course, show that it is impossible that the motile Acineta-embryo should be transformed into a *Vorticella,* and a *Vorticella-cyst* into an *Acineta;* but the field of possibilities is very wide, everything is possible if it only be founded on facts. I believe, therefore, that it may justly be concluded that Stein's Acineta-doctrine, as concerns *Vorticella microstoma,* Ehr., must be regarded as *hypothetical,* and not based upon *facts.*

VARIOUS DIMENSIONS.

Diameter of the *Podophrya fixa* .	. 0·04 —0·07m.
Length of peduncle . . .	. 0·025—0·05m.
Thickness of ditto . . .	. 0·005m.
Length of divisional embryo .	. 0·075m.
Breadth of ditto . .	. 0·06m.
Diameter of the cyst . .	. 0·05—0·08m.
Length of peduncle of cyst . .	. 0·03m.
Thickness of same at the cyst .	. 0·025m.
Diameter of enclosed globular body .	. 0·05m.

NOTES AND CORRESPONDENCE.

The Infusoria.—Great uncertainty still prevails with respect to the internal organs of these forms, and from the details recently published regarding them (chiefly abroad), it appears that a more intimate knowledge of their physiology tends to show that, although not so highly organized as they were represented by Ehrenberg, they are not so simple in their internal structure as they were supposed to be by some later observers.

Under these circumstances, I may be allowed briefly to submit the chief results of my observations during the past twelve months, so far as they bear upon the subject under consideration.

Alimentary vesicles.—Having repeatedly watched the ingestion of food, both with and without adding indigo to the water in which the Infusoria were contained, I have frequently observed—1st. The alimentary particles, which are driven in by the action of the oral cilia, and are accompanied by more or less water, enter the gullet, accumulate just *beyond* its termination within the body, and there form a ball. This ball, as is well known, sinks into the body after it has attained a certain size. 2d. That the globules or balls thus formed appear fixed in *Glaucoma*, &c., and to rotate in *Nassula*, &c., as mentioned in your number of last January. But I would now add, that in the former types they also move, but so slowly, that their motion is only perceived after long and careful observation. 3d. Sometimes, when there have been but few particles of indigo, I have seen the globule formed by the admission of *water*, and *within that globule* small particles of indigo rotated rapidly so long as the process of formation continued; but as soon as the globule sank into the body, the rotation ceased. This must not be considered as a proof that the action of the oral cilia is constant and mechanical; for I have often seen *Glaucoma scintillans* with its body as clear as crystal, and perfectly free from food-globules or any vesicles, excepting the contractile vesicle. The alimentary vesicles appear to get rid of their contents gradually, the refuse passing through the anal orifice, wherever that may be situated.

Contractile vesicles.—Of the various theories that formerly existed concerning these organs, two opposite ones still

remain. By some microscopists they are regarded as portions of a water-vascular system—these observers believing that they have found an external opening communicating with the water; by others they are supposed to form a rudimentary circulating system (heart), by which the liquid produced from the digestion of food is circulated through the body; my own *present* view will be gathered from the following observations:

The contractile vesicle I have almost invariably found to be near the surface of the body.

Glaucoma scintillans is furnished with *one* central vesicle, and when that contracts, it forces the fluid into others which appear to be temporarily formed around it; these in their turn amalgamate and form the central vesicle by fusing their contents together. This, I believe, to be the whole circulation in the form named, and I do not find in this case that the surrounding vesicles have any outlets or canals as described by Lieberkühn. The central vesicle I have almost always found to be on the side furthest removed from the object-lens (the animalcule appears to move in this position), and the *auxiliary vesicles* are formed *inwards—i. e.*, the fluid rises *into* the body, and there forms the vesicles. This may be tested by raising the object-lens whilst the central vesicle is contracting, and depressing it when the amalgamation takes place (of the smaller vesicles). I believe that my observation in this respect is accurate, as I have frequently repeated it, and am therefore somewhat inclined to regard the contractile vesicle as a heart; that it should be near the surface is natural, and by bringing the nutritive fluid into close contact with the water, it renders the admission of that medium *into* the body unnecessary. The nutritive fluid seems to alternate between the central and surrounding vesicles.

In *Paramecium caudatum*, a species of *Amphileptus*, a freed *Vorticella*, &c. I have frequently and clearly traced the canals that empty themselves into the contractile vesicle. In the second-named species, these canals were very perceptible; they proceeded along the edge of the body where the cilia were the most active (also probably because there the current of fresh water would be constantly renewed), and at the embouchure into the central vesicle, swelled into a bulb-shape. In the *Vorticella, the contractile vesicle had a canal which communicated either with the external surface, through the oral aperture,* or passed *round* the oral wreath. I was inclined to believe the latter to be the case (perhaps my bias may have influenced the observation).

In certain Infusoria there appears to be a more active vital power than in others. Thus, in *Glaucoma*, *Vorticella*, &c., the food-balls move very slowly, whilst in more highly organized types the motion is more rapid. In the former (especially such as are probably larval forms), the contractile vesicle appears to have the power only to form a row of auxiliary vesicles around it; whilst in *Amphileptus* (which approaches the Planarians in its character), the Setifera or bristle-bearers, and other types, it is more powerful, and the fluid is ejected with sufficient force to work its way into the body, and form canals, or arteries, however primitive they may be. The progressive vitality I have often noticed in the same form at different stages of its growth.

The foregoing remarks are not made for the purpose of pushing forward my own views and opinions, for these must necessarily become changed or modified as the science progresses; but with a view to direct observation to the subject, and obtain for it a greater share of the attention of English microscopists than has hitherto been bestowed upon it.—JAMES SAMUELSON.

When are Diatoms common in a Slide?—All who have received gatherings of diatoms have been frequently puzzled by the observations which accompanied them in regard to the scarcity or abundance of a particular species; and it appears to me that some law on the subject would be of essential service, and might save many from disappointment. Unless it be mentioned that the species sought is only to be met with in the heavier or lighter portions, it is understood that the average is intended, as obtained by shaking the little tube in which the preparation or "boiling" is kept; and with that understanding, the following observations will indicate the principles on which more definite terms may be founded.

Dr. Gregory, in last number of the 'Micr. Soc. Trans.,' enumerates 304 species found in the Glenshira Sand, of which, however, a few appear not to be diatoms; some supposed new, seem (if one may judge from the descriptions and figures) to be only varieties of well-known species, and others are of that extreme scarcity as not to form $\frac{1}{10000}$ *per cent.* of the preparation, and therefore are to be seen in few of the slides; on no one slide can there be said to be 200 species. Again, according to Smith's Synopsis of Diatomaceæ, there appear to about 500 species in Great Britain; as nearly one half of these are marine, the rest from fresh

water, and as we cannot expect all of each sort to be present in a gathering, the above number (200) is an ample allowance, and I myself have never seen so many in a slide.

Assuming this to be the probable number, each species ought to occupy a space equivalent to the $\frac{1}{200}$th part of the area allowed for diatoms, or portion protected by the cover. As the specimens should not be crowded, I hope that I make a liberal allowance for a vacancy, when I ask only the $\frac{1}{500}$th part of the whole area to be devoted to any one species, in order that it may have as much space allotted to it as to the others; when, therefore, it occupies the $\frac{1}{500}$th part, it ought to be called neither "common" nor "rare." To this line there may be allowed a margin, so I propose that when a species occupies from the $\frac{1}{200}$th to the $\frac{1}{1000}$th part, it may be denominated as above; and this may be conveniently divided into those which occupy from the $\frac{1}{200}$th to the $\frac{1}{500}$th, and from the $\frac{1}{500}$th to the $\frac{1}{1000}$th part; the former receiving the name of "not common," the latter of "not rare." In the same way from $\frac{1}{40}$th to $\frac{1}{200}$th may be called "common," and from $\frac{1}{1000}$th to $\frac{1}{3000}$th "rare;" beyond these extremes, on either side, we have "very common," and "very rare."

To apply this: If the cover be about half an inch = ·5 in diameter, the area of diatoms is ·5 × ·5 × ·7854 = ·2 nearly; in which case, if a species does *not* occupy $\frac{2}{3000}$ = ·00004, it is "very rare;" from that to ·0002 "rare;" from that to ·0004 "not rare," from that to ·001 "not common," from which to ·005 "common," and if more copious, "very common." In measuring any diatom, it is sufficient to multiply together the length and greatest breadth, allowing the vacancy caused by its not having a rectilinear figure to be added to the vacancy already mentioned. If we now take *Campylodiscus costatus*, its length and breadth in the untwisted state is about ·003, and its surface, got in the way just alluded to, ·00001 nearly; hence dividing by this number, we get less than 4 frustules when "very rare" (*v.r.*), in a slide, from 4 to 20 when "rare" (*r.*), from 20 to 50 when "not rare" (*n.r.*), 50 to 100 when "not common" (*n.c.*), and from 100 to 500 when "common" (*c.*) In *Eunotia tetraodon*, the average length is about ·002, and breadth ·001, and surface ·000002; hence, when there are not $\frac{\cdot 00004}{\cdot 000002}$ = 20 under a cover half an inch in diameter, it is "very rare," from 20 to 100 "rare," and so on. In *Navicula cryptocephala*, the average surface is ·0011 × ·00035 = ·0000004 nearly; so when there are

not $\frac{\cdot 00001}{\cdot 0000004} = 100$ in the slide, it must be accounted "very rare;" above 100, but not exceeding 500, "rare" only, this giving almost one to every field of a "$\frac{1}{4}$" object-glass.

And this leads me to observe that when the specimens are small, or so numerous that they are entitled to be called "common," they ought to be seen in every field of a "$\frac{1}{4}$" object-glass; and then we may decide on the appellation to be given by counting those observed in the field at one time, or by taking an average of two or three fields. The object-glass I employ has, with a low eye-piece, a field of ·02 inch in diameter, and therefore an area of about ·0003 nearly; hence to be "not common," each species ought to occupy from $\frac{\cdot 0003}{500}$ to $\frac{\cdot 0003}{200}$, that is from ·0000006 to ·0000015; and to be "common" from ·0000015 to ·0000075. In the case of *Campylodiscus costatus* already mentioned, its area is ·00001; and as the greatest of these numbers (·0000075), divided by ·00001, only gives ·75 or $\frac{3}{4}$, only three specimens may be expected in four fields of view; and therefore, although one only occurs in every field, the species ought to be esteemed "very common." In *Eunotia tetraodon*, the surface is ·000002; hence, when there are from one to four in the field at once, it may be called "common," more than that "very common." *Navicula cryptocephala* has a surface of ·0000004; and as $\frac{\cdot 0000006}{\cdot 0000004} = \frac{3}{2}$; so, unless are there at least three specimens to every two fields of view, the species must be held as only "not rare," if, indeed, it be not "rare," or "very rare," when we must have recourse to the area of the cover.

A very slight practice will render the actual calculation unnecessary; but there ought to be some check, for many slides sold are almost worthless, from not containing specimens of the species labelled, and for which it is purchased, in a sufficient number to illustrate its variations.—A.

The Microscope as a means of Diagnosis.—*Singular case of Intestinal Concretions.*—The value of the microscope as a means of diagnosis is now universally acknowledged by every medical man. Many are the instances I could enumerate, in which, without its assistance, no clear or definite opinion could be arrived at. Among the many cases which have come under my observation, the following one may not be uninteresting, as I know of no other similar case, save one mentioned by our esteemed friend, Mr. Quekett, in his first volume on 'Histology.' I give you the history of the case

as detailed to me by Dr. Wilkinson, of Manchester, under whose care the patient was placed, and to whose kindness I am indebted for the account.

R. L—, aged 52 years, a power-loom weaver, has never been the subject of any ailment until four years ago; in fact, he does not remember ever having had a day's illness. At that time he suffered slightly from indigestion, felt some uneasiness at the pit of the stomach, with at times, though rarely, actual pain. The food taken frequently returned at intervals, varying from ten minutes to two or even four hours after ingestion. The vomit, if retained for some hours, presented the appearance of butter-milk and treacle. He never vomited except when the stomach contained food; but he was subject to frequent eructations of a small quantity of clear fluid, intensely acid; sufficiently so to set the teeth on edge, and to produce even a shudder at the recollection. About this time he perceived a hard body directly below the ensiform cartilage, but somewhat to the right side, lying as it were between the depending point of the cartilage and the right costal cartilages. He judged that the lump he felt was a hard substance about the size of a hen's egg. He felt this lump pass down along the course of the duodenum and intestines, until it arrived in the left hypochondriac region. A short time after this it was passed by stool, being several weeks after he had first noticed it. The whole of the time he had severe and continued pain; and after it had passed, per rectum, he suffered for thirteen hours severely. Sixteen days afterwards another concretion was passed; and at the end of sixteen days more one still larger. There were no other concretions passed for two years, and then another of a smaller size.

He then felt a hard tumour in the abdomen on the right of the umbilicus which has since gradually increased; continuing hard, moveable, and somewhat changes its position, but does not seem to move along the canal.

The concretions which have been passed have not varied greatly in appearance being irregularly oval. The one he presents is hexagonal, apparently presenting articular facets of a lightish brown colour.

He states that he has lived since childhood principally on oatmeal porridge with treacle, has taken little animal food; and, during the four years he has been unwell, has taken magnesia as a purgative. He, however, says that he took no magnesia before the first concretion was passed.

Such is the case as sent me by my friend with a portion of the concretion for microscopic analysis. Chemistry and

all other means had failed to unravel the mystery of the composition of this concretion. I macerated a portion of it for some time in distilled water, expecting to detect the starch granules of the oat by the polarizing apparatus of the microscope, but in this I failed. I continued the maceration, separating the parts a little with very fine needles,

and at last was able to detect very beautifully masses of the hairs of the palea of the oat, of which, and the husks of the oat, the concretion seemed to be entirely made up.

I need say no more, the value of the microscope in this case is undeniable; and I have only to present you with a slide and a drawing of the analysis for your own inspection. —H. Munroe, M.D., Hull.

On Microscopic Apparatus.—Allow me to call your attention, and that of your readers, to two little contrivances of mine, as they may be found useful.

The first is a simple apparatus for illuminating objects under the microscope; and will be found particularly of use when examining Diatomaceæ. Knowing that there are many microscopical observers like myself, not able to expend large sums in accessory apparatus to the microscope, I particularly recommend it to their notice.

It consists of a plate of glass (s, fig. 1) (an ordinary slider), three inches by one; to one side of which, in the centre, is attached, by Canada balsam, a *plano-convex* lens (L), and this may be of about one quarter-inch focus. Lenses of different powers can be used, although I have found one of half-inch and one of a quarter-inch focus to be the most useful. The way in which this is used is seen in the first figure. The rays of light (R) fall on the lens (L), placed on the microscope-stage (K), so that the flat side is uppermost, upon which is

placed the object to be examined. The rays are brought to a focus (F), at some distance above the object (O), thus giving an even white light over the whole field of vision, and this I have found particularly advantageous when using low powers

Fig. 1.

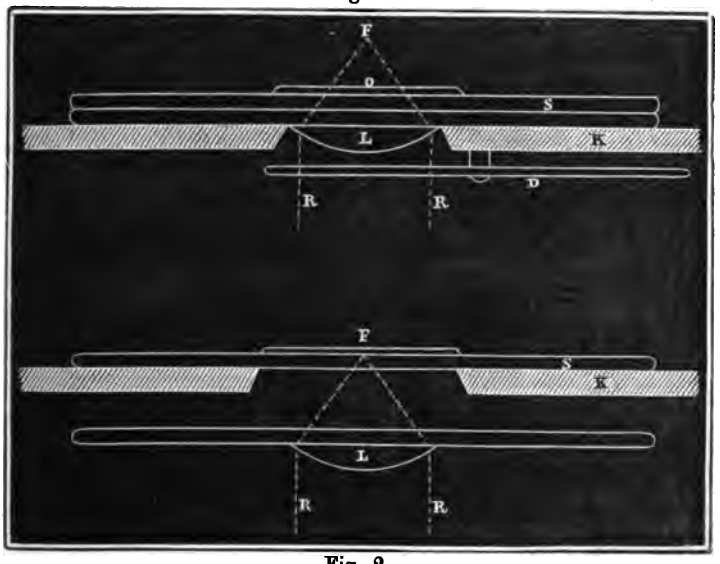


Fig. 2.

for viewing objects. We can modify this arrangement by placing the lens below the stage (as in fig. 2), and at a point where it can be adjusted by a rack and pinion, so that the rays from it are focussed on the object. However, the first arrangement I have found the most generally useful. To this can be added a diaphragm (fig. 3), which any one can make for himself, to fit the microscope, of blackened cardboard. The general utility and cheapness of this simple contrivance will, I think, recommend it to the consideration of all whose purses are not as large as their desire for knowledge.

I should also mention that I have found this illuminator particularly useful on dull days, when, by the mirror alone, only a gray light could be obtained, while, with the addition of my condensing lens a clear white light is obtained; and, from the reason of most of the rays falling obliquely on the object, the markings of certain of the Diatomaceæ can be easily resolved with it. When the diaphragm (fig. 3) is

added, with its numerous apertures, and which can be varied to suit the fancy, we get an apparatus which, on important occasions, will be found to fill the place of the more expensive achromatic condenser.

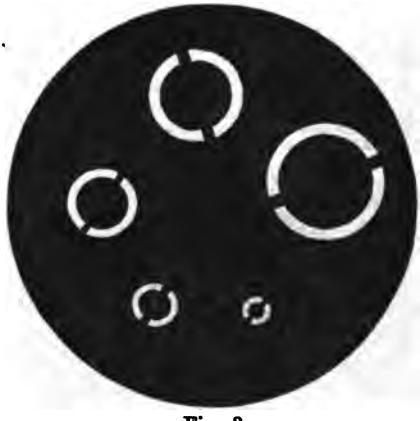


Fig. 3.

The second contrivance of which I have to speak is a clasp to hold bottles at the end of the rod with which the searcher for minute organisms is provided. Many microscopists have found the ordinary contrivances, for this pur-

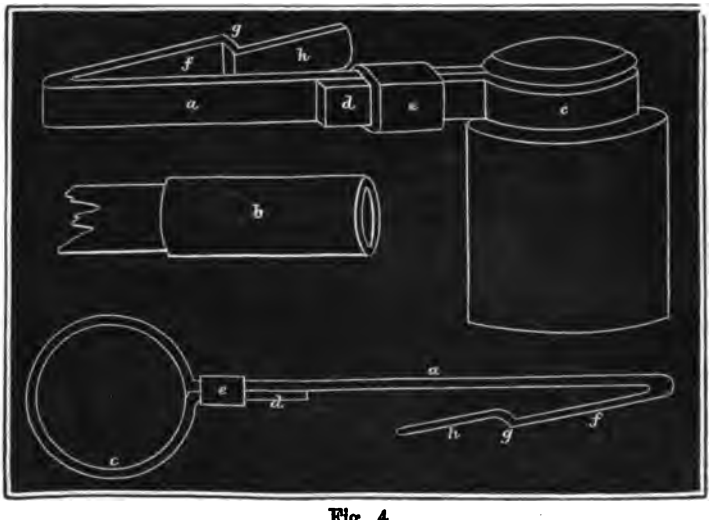


Fig. 4.

pose, troublesome or requiring fine workmanship; and have been led to invent more simple ones for their own use—thus has it been with me.

My clasp consists of a strip of sheet-brass (*a*, fig. 4), ten inches by one half of an inch, and about as thick as stout Bristol board; indeed, so thick that it will bear the weight of a two-ounce bottle without bending. This is bent, as is seen in the figure (4), and around it is wrapped another piece of brass, so loosely that it will slide upon it. To the end of the rod which is used for the purpose, is attached a brass tube (*b*), the end of which is slightly turned over, inwards. The bottle is now placed in the loop (*c*), and the end (*d*) being brought down on *a*, the slide (*e*) is pushed up so that it holds and clasps the bottle firmly. The spring part (*f*) is now forced into the ferule (*b*), until the catch (*g*) holds it in its place. When it is wished to remove it, we have but to press the spring-catch at *h*, and it can easily be taken out of the ferule.

I offer these remarks with much readiness, and shall be pleased if you deem them worthy an insertion in your valuable periodical.—Arthur M. Edwards, College of Physicians and Surgeons, New York City, U.S., October 20th, 1856.

PROCEEDINGS OF SOCIETIES.

MICROSCOPICAL SOCIETY, *September 29th*, 1856.

GEORGE SHADBOLT, Esq., President, in the chair.

A short Communication from the Rev. S. G. Osborne, being a continuation of his Paper "On the Growth of the Wheat Plant," was read.

A Paper, by J. S. Bowerbank, Esq., "On the Structure and Vitality of the *Spongiadæ*," was read.

November 26th, 1856.

GEORGE SHADBOLT, Esq., President, in the chair.

J. Brand, Esq., 36, Nicholas Lane; Jas. Hopgood, Esq., Clapham Common; Dr. T. H. Barker, Bedford; Dr. Shearman, Rotherham; John Anderson, Esq., 4, Bedford Terrace, Clapham Rise; and E. C. Hulme, Esq., 19, Gower Street, were balloted for, and duly elected members of the Society.

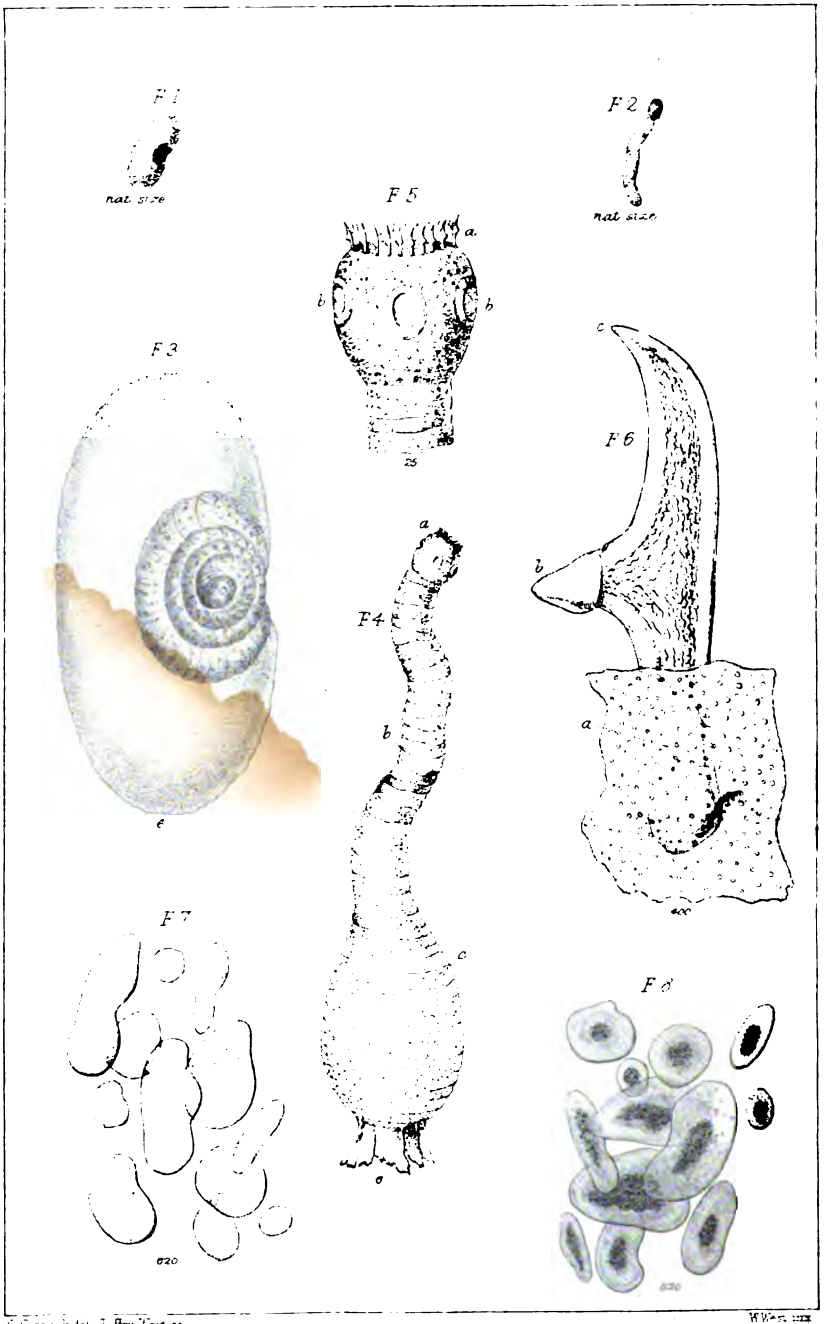
Dr. Lankester made some remarks explanatory of the Rev. S. G. Osborne's views respecting the Growth of Plants.

December 10th, 1856.

GEORGE SHADBOLT, Esq., President, in the chair.

Charles May, Esq., H. C. Rothery, Esq., Dr. Donkin, John Loxley, and Dr. Ladd, were balloted for, and duly elected members of the Society.

A discussion on the expediency of introducing one uniform Screw for Object-Glasses, took place.



C. Rippingille del. J. Ellis West sc.
W. West imp.

DESCRIPTION OF PLATE II,

Illustrating Professor Smith's paper on Measled Pork.

Fig.

1.—The "measles," as it appears to the naked eye, taken from fresh pork.

2.—The appearance of the "measles" taken from salted pork.

3.—The *Cysticercus* and its cyst, magnified 6 diameters.

4.—The animal withdrawn from its cyst, which is broken away, magnified 6 diameters.

5.—The head of the *Cysticercus*, magnified 25 diameters.

6.—A hooklet, magnified 400 diameters.

7.—The "assimilating cellules" of a living *Cysticercus*, magnified 620 diameters.

8.—The same in a *Cysticercus* from salted pork.

DESCRIPTION OF PLATE III,

Illustrating Dr. Greville's paper on Trinidad *Diatomaceæ*.

Fig.

1.—*Cocconeis punctatissima* (a small example), showing the median line as it appears when both valves are united.

1*—The same; a single valve.

2.—*Cocconeis crebrestriata.*

3.— „ *inconspicua.*

4.—*Campylodiscus fenestratus.*

5.— „ *Ecclesianus.*

6.—*Surirella eximia.*

7.—*Navicula Gregoriana.*

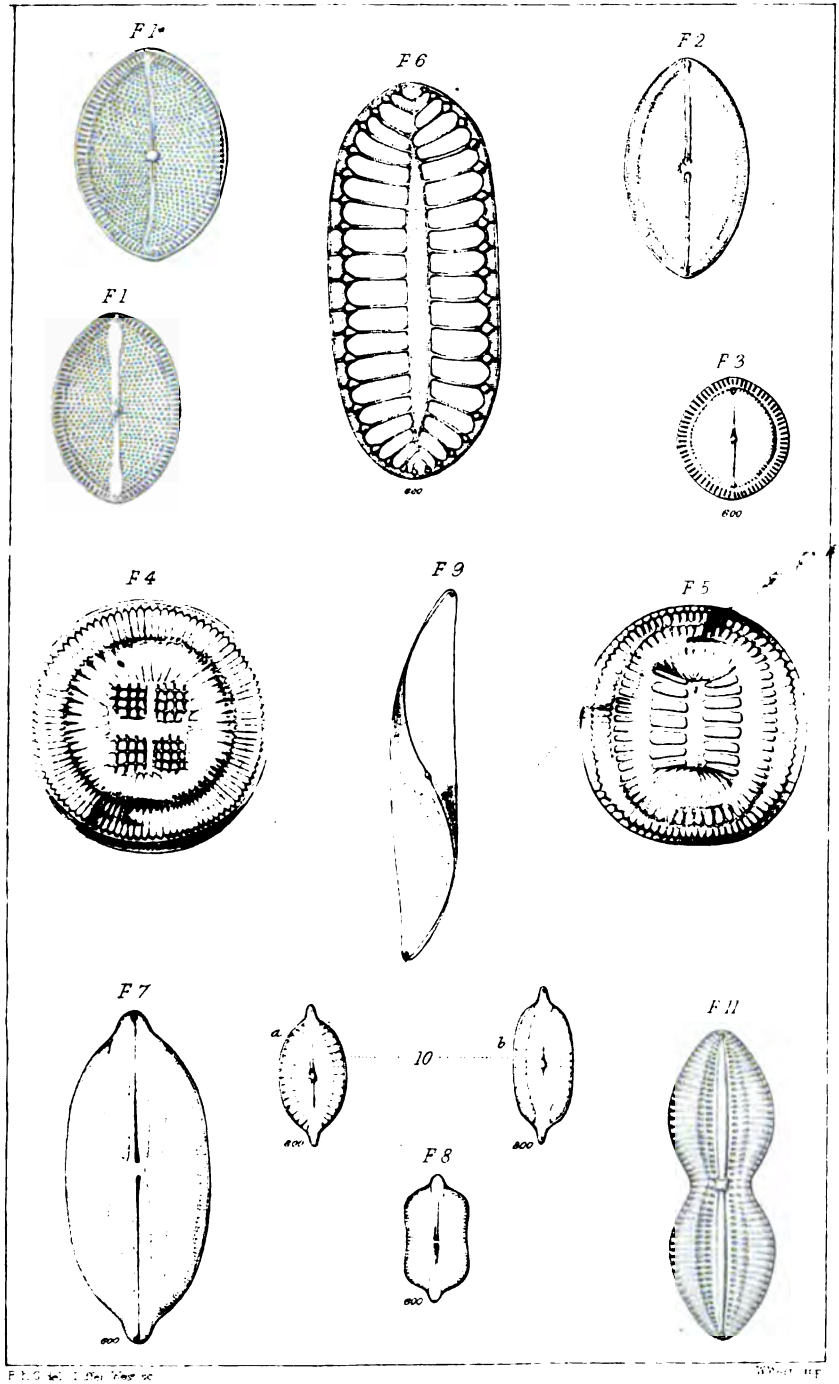
Since the description of this Diatom was printed, I have been led to suspect that it may possibly prove to be *Navicula lyra*, Ehr., as the blank linear spaces in that species seem to be very variable in their character.

8.—*Navicula compacta.*

9.—*Pleurosigma compactum.*

10.—*Mastogloia minuta.*

The scale adopted is that of Professor Smith in his admirable Synopsis, except when otherwise indicated.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a.
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b
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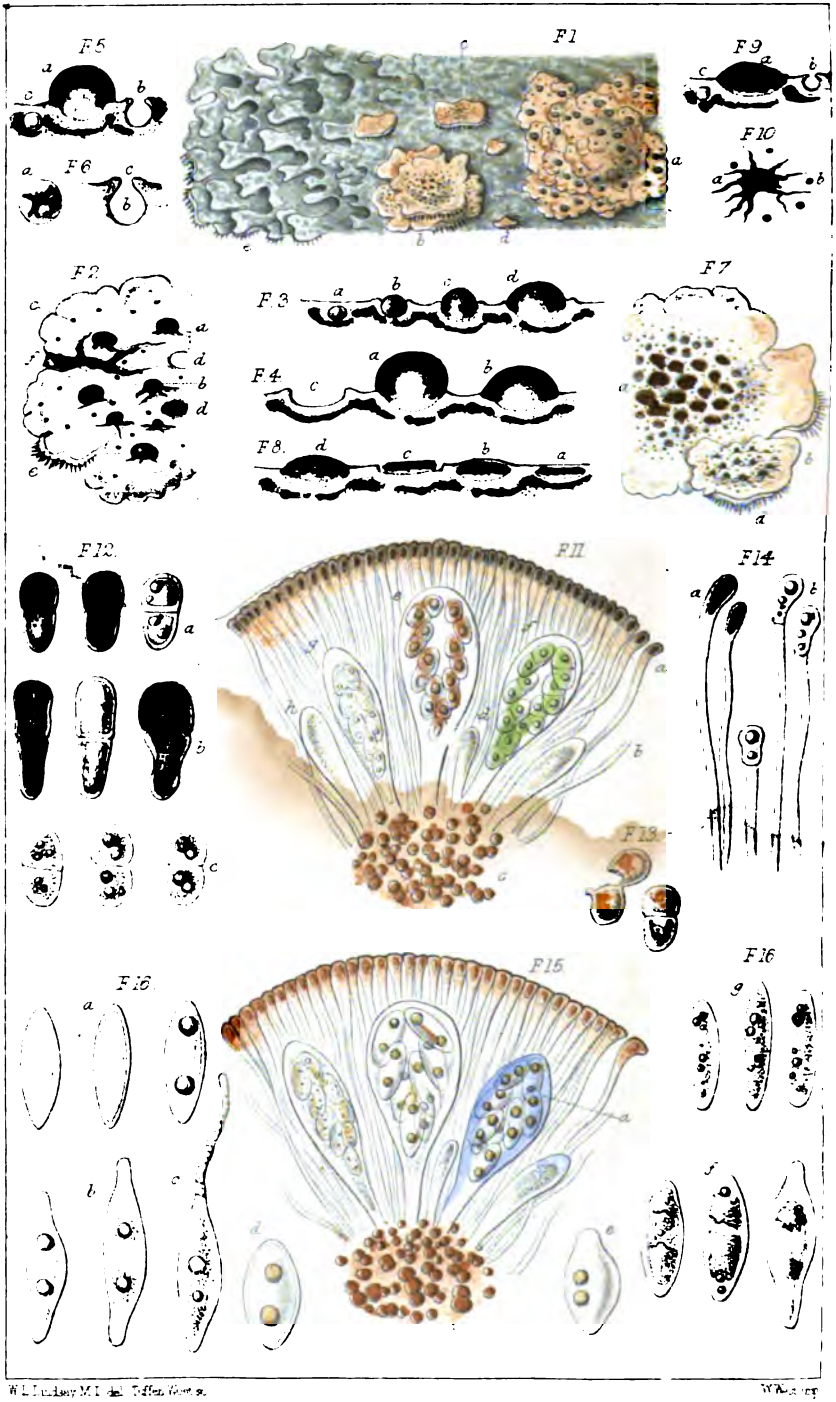


W. L. Lindsay M.D. del. Tuffen West sc.

W. Ward sc.

DESCRIPTION OF PLATES IV, V,

Illustrating Dr. Lindsay's paper on the Genus Abrothallus.*

PLATE IV.

Fig.

1.—Portion of furfuraceous thallus of *Parmelia saxatilis*, bearing both *Abrothallus Smithii* and *A. oxysporus*.

a. *A. Smithii*—showing apothecia and intermixed pycnides. The portion of thallus on which it is parasitic differs in colour and other characters from the ordinary thallus of *P. saxatilis*: it is becoming globose from the curling of the margins and the superposition of squamules or lobes.

b. *A. oxysporus* in its young state. The squamules are more flattened, or concave, and simple than those habited by *A. Smithii*.

c. A young and simple squamule, bearing only the spermogones of *A. oxysporus*.

d. Rudimentary, as yet sterile, squamules. The black-fibrillose nature of the under surface may be observed.

e. Ordinary laciniæ of *P. saxatilis*, showing their retuse extremities and the black-fibrillose under surface.

2.—Portion of thallus bearing *A. Smithii*, magnified.

a. Mature apothecia.

b. Young emergent apothecia causing fissuring of the cortical layer of the thallus.

c. Pycnides.

d. Cyphelloid foveolæ (produced by the falling out of the apothecia) with raised dark margins. In one, the medullary tissue thus exposed is seen to be white; in the other, red.

e. Black-fibrillose under surface of thallus.

f. Fissure showing rusty red medullary tissue (common in Highland specimens).

3.—Section of young apothecia of *A. Smithii*, showing their mode of evolution from, and relation to, their matrix.

a. Young apothecium covered by a veil of the cortical tissue of matrix.

b, *c*, *d*. Young apothecia gradually emerging through cortical layer.

4.—Section, showing mature apothecia *a*, *b*, and foveola *c*.

a. Globose.

b. Somewhat deplanate.

c. Urceolate foveola left by falling out of an old apothecium.

5.—Section, showing relation of the pycnides to the apothecia.

a. Mature apothecium.

b. Mature pycnidis.

c. Young or non-developed pycnidis.

* The observations, from which the illustrations of minute structure were drawn, were made chiefly under power 380 of a Nachet's microscope.

PLATE IV (*continued*).

Fig.

6.—Pycnides of *A. Smithii*.
  a. Showing the stellate-fissured ostiole.
  b. Section showing cavity *b*, and ostiole *c*.

7.—Portion of thallus bearing *A. oxysporus*, mag.
  a. Mature apothecia.
  b. Young or emergent apothecia causing radiate-fissuring of cortical layer. The squamule is covered with a network of such fissures.
  c. Spermogones intermixed with young apothecia.
  d. Black-fibrillose under surface.

8.—Section, showing the relation of the apothecia of *A. oxysporus* to the matrix.
  a, b. Young apothecia covered by a veil of cortical tissue.
  c. Mature apothecium; flattened, resembling a plano-convex lens.
  d. Mature apothecium; convex and discoid.

9.—Showing relation of spermogones to the apothecia of *A. oxysporus*.
  a. Mature apothecia.
  b. Mature spermogone.
  c. Young or non-developed spermogone.

10.—*a*. Young apothecium of *A. oxysporus* causing fissuring of the cortical tissue of matrix, through which it is bursting.
  b. Spermogones.

11.—Section of portion of apothecium of *A. Smithii*.
  a. Tips of paraphyses, of a much darker brown than those of *A. oxysporus*.
  b. Filaments of paraphyses.
  c. Hypothecium, consisting of a brownish cellular tissue.
  d. Young thecæ, full of a homogeneous or finely granular, pale or colourless protoplasm.
  e. Mature theca full of nearly ripe spores.
  f, g, h. Thecæ at earlier stages of development. The button-like markings of the young spores is shown at *f*.
  i. Apparent membrane connecting the apices of the paraphyses.

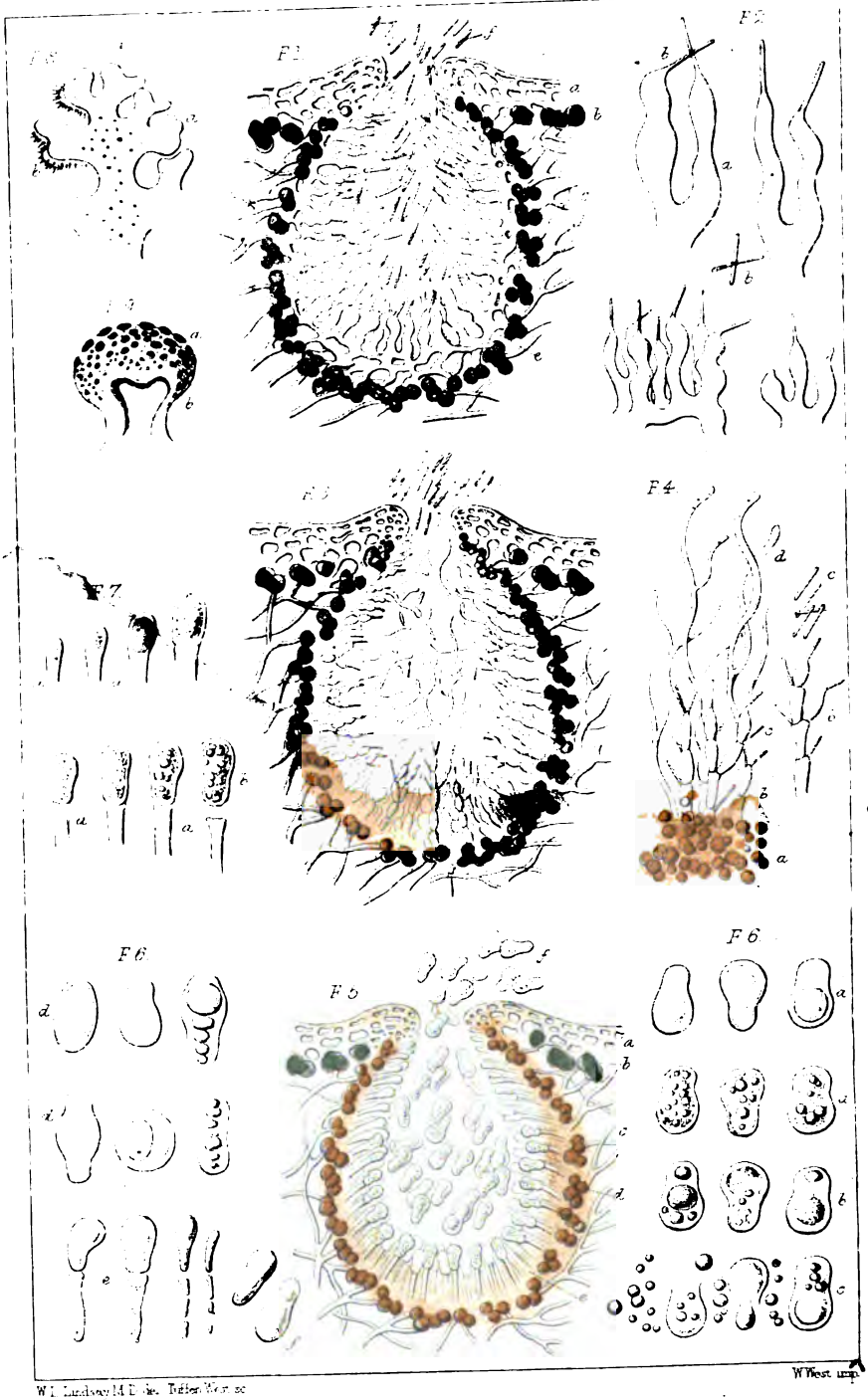
12—Spores of *A. Smithii* in different stages of development.
  a. Mature spores showing the two loculi and their unequal size, as well as the nuclei which frequently occupy them.
  b. Deformities by elongation. Usually found only in old apothecia and in Highland specimens.
  c. Young spores, showing the gradual division into loculi, the appearance of nuclei, and the acquirement of colour.

13.—Old spores, undergoing a process of disintegration.

14.—Paraphyses of *A. Smithii*, isolated.
  a. Unaffected by reagents, showing dark brown extremities.
  b. Under action of aqua potassæ, showing the terminal cells, which have acquired a resemblance to stylopores.

15.—Section of a portion of the apothecium of *A. oxysporus*.
  a. Showing action of iodine on the thecæ.

16.—Spores of *A. oxysporus* in different stages of development.
  a, d. Mature spores, showing the occasional double contour and terminal nuclei.
  b. Deformities by elongation.
  c. Spore in process of germination.
  e, f. Old spores, undergoing a process of disintegration.
  g. Young spores with a granular protoplasm.



W. West imp.

W. L. Lindsay M.D. Edin. Indian Mor. sc

PLATE V.

Fig.

1.—Section of a spermogone of *A. oxysporus*.

a. Cortical tissue of deformed portion of thallus of *P. saxatilis* on which the plant is parasitic.

b. Gonidic tissue of same.

c. Medullary tissue of same.

d. Envelope of spermogone formed of a brownish cellular tissue.

e. Sterigmata forming the inner walls of the spermogone, and generating the spermatia from their apices.

f. Free spermatia escaping by spermogonal ostiole.

2.—Sterigmata and spermatia more highly magnified.

a. Sterigmata.

b. Spermatia.

3.—Section of a spermogone of *P. saxatilis*. Its structure is similar to that of *A. oxysporus*; but the sterigmata are seen to be articulated, the spermatia to be generated from both sides and apices, and the interior of the spermogone to be occupied by a loose network of very delicate, ramose filaments, which spring, along with the sterigmata, from the inner walls of the spermogone.

4.—Portion of the tissues forming the spermogonal walls, more highly magnified.

a. Component cells of the brown envelope.

b. Articulated sterigmata.

c. Spermatia, which arise generally at an angle from the apices of the constituent joints or articulations of the sterigmata.

d. The ramose delicate filaments, whose anastomoses and intertwinings constitute the network of the spermogonal cavity. Some of them appear septate or articulated at the apex, where also they are generally granular and dark.

5.—Section of one of the pycnides of *A. Smithii*.

a. Cortical layer of matrix (deformed thallus of *P. saxatilis*).

b. Gonidic layer of the same.

c. Medullary tissue of the same.

d. Brownish cellular envelope.

e. Sterigmata close-set, short, delicate, forming the inner wall of the pycnidia, each bearing at its apex a stylospore.

f. Free stylospores escaping by the ostiole.

6.—Stylospores in different states and stages of development. Many of them are seen to contain large or small oil globules, or to be filled with an oily protoplasm.

a. Mature stylospores. The colourless transparent specimens are full of a homogeneous, oily, liquid protoplasm.

b. The same, from some Highland localities. The oil globules have here a yellowish tinge.

c. Shows the effects of pressure or reagents in rendering more evident the oily nature of the protoplasm. The oil globules are seen escaping from the ruptured stylospores, and many of them are floating free.

d. Stylospores of large size and irregular form from various Highland

Fig.

specimens of *A. Smithii*. Some of the specimens figured resemble certain compound or cellular spores; others might be mistaken for empty gonidia.

e. Stylospores retaining their sterigmata. They are of small size, and somewhat shrivelled. Those coloured yellow are from Highland localities.

f. Small yellow stylospores from Highland localities.

7.—Development of the stylospores from their sterigmata.

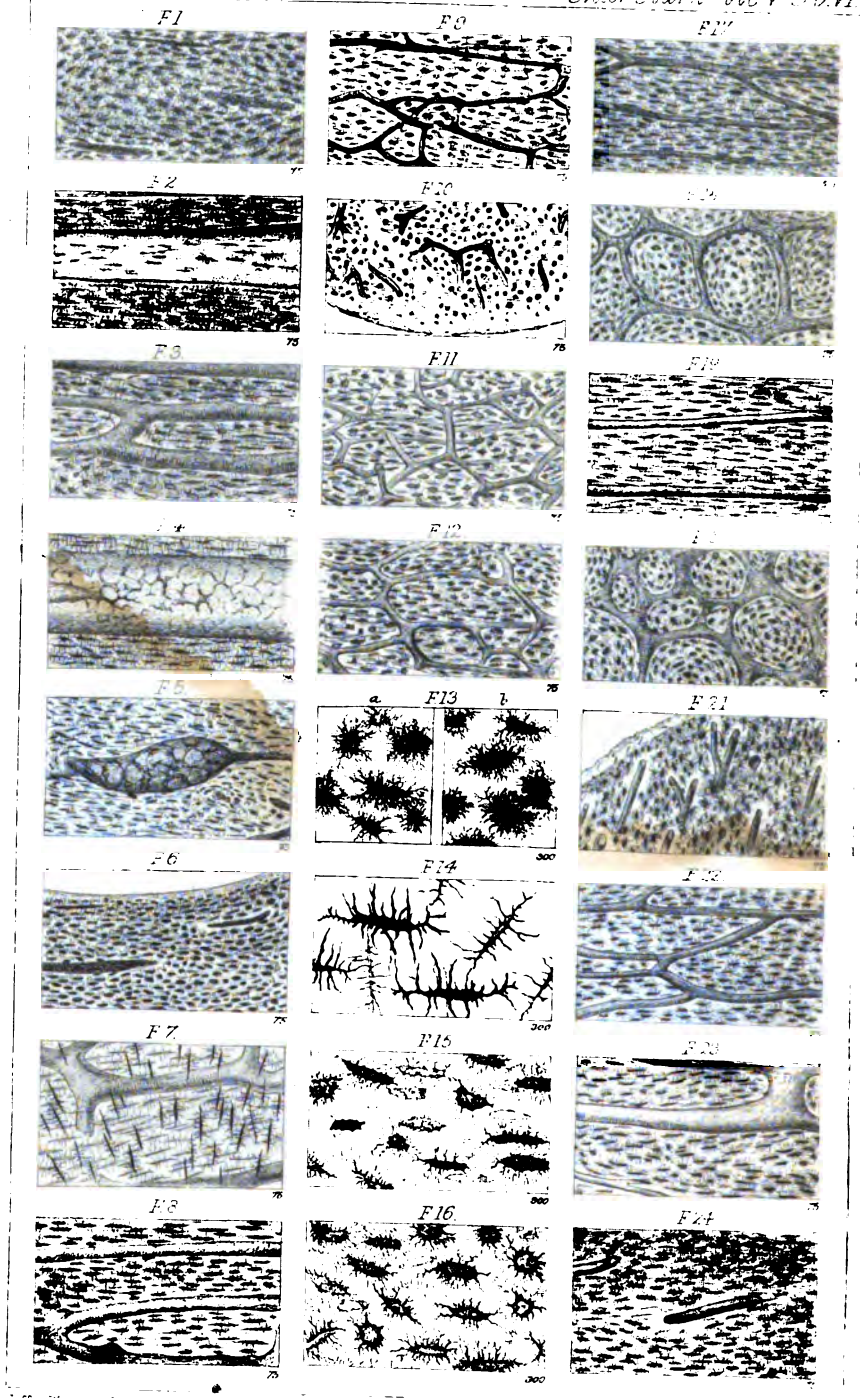
a. Sterigmata.

b. Stylospores.

The sterigmata appear first as simple filaments, with a rounded or bulging extremity; this gradually becomes dilated and separated from the sterigmata by a septum. The terminal cell then constitutes the stylospore, which speedily falls off, and for some time increases in size, acquiring more of a pyriform shape.

8.—Portion of the thalline laciniæ of *P. saxatilis*, showing the spermogones *a*, and the black-fibrillose under surface *b*.

9.—Bullose dilatation of thallus of *Cetraria glauca*, bearing the apothecia and spermogones of *A. oxysporus*. The section shows that it is hollow and stipitate.



Jeffers West sc. ad nat.

J. B. Pearman lith. ad nat.

DESCRIPTION OF PLATE VI,

Illustrating the Rev. J. B. P. Dennis's paper on Fossil Bones from the Stonesfield Slate.

Fig.
1.—Pteropus; humerus.
2.—Bat; phalanx.
3.—Flying phalanger; tibia.
4.—Draco volans; ulna.
5.—Red-throated diver; tibia.
6.—Swift; furcula.
7.—Mr. Catt's fossil (pterodactyle).
8.—Pelican; bill.
9.—Stonesfield fossil, vertical section.
10.— Ditto, transverse section.
11.— Ditto, vertical section.
12.—Heron; humerus.
13.—*a.* Heron; humerus.
b. Stonesfield fossil; lacunæ.
14.—Mr. Catt's fossil (pterodactyle); lacunæ.
15.—Stonesfield fossil; lacunæ.
16.—Heron; lacunæ.
17.—Gannet; humerus.
18.—Ditto; coracoid.
19.—Ditto; furcula.
20.—Ditto; femur, vertical section.
21.—Ditto; femur, transverse section.
22.—Ditto; tibia.
23.—Ditto; tarsus.
24.—Ditto; rib.

* Figs. 13, 14, 15, 16, magnified 300 diameters, the remainder 75 diameters.

DESCRIPTION OF PLATE VII,

Illustrating Dr. H. Cienkowski's paper on Acineta-Forms.

Fig

1.—Transverse division of *Podophrya fixa*, Ehr.

2.—The divided *Podophrya* with the half becoming detached.

3.—The independent segment.

4, 5.—Stages towards encysting.

6, 7, 8.—Cysts of *Podophrya fixa*, Ehr.

9.—An *Acineta* with rotating embryo.

10.—An *Acineta* with the embryo escaping.

11.—The embryo, after a prolonged motile stage, becoming transformed into an *Acineta*.

12.—The transformation of the embryo into an *Acineta* completed.

The figures 1—8 are × 370 diam., 9—12 × 170 diam.

Illustrating Mr. Huxley's paper on Dysteria.

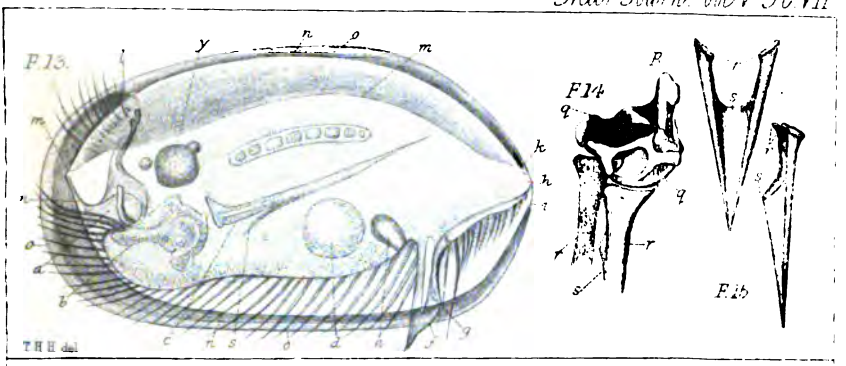
13.—*Dysteria armata*.

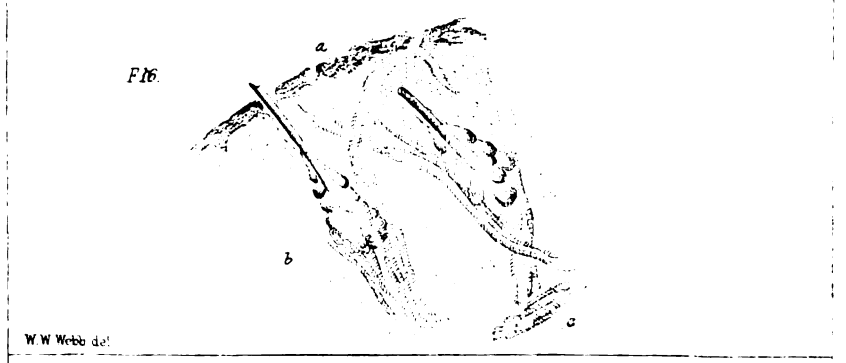
14.—Parts of mouth of ditto.

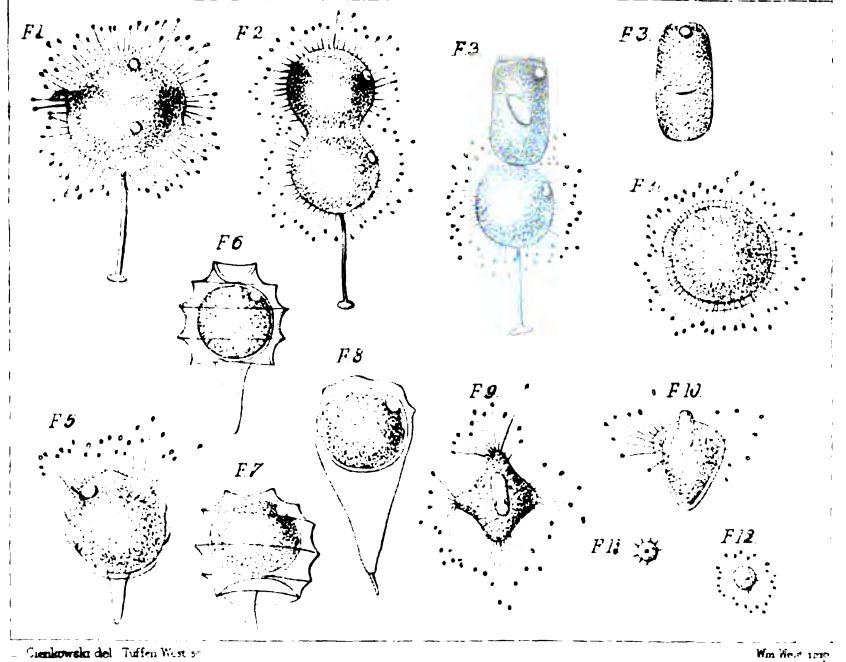
15.—Process between two styles.

Illustrating Dr. Webb's paper on the Human Lip.

16.—Muscular fibres in skin of human lip.







Cienkowski del. Tuffen West sc. Wm. West imp.

ORIGINAL COMMUNICATIONS.

On some points in the Structure *and* Physiology *of certain* Fungi, *with notices of the occurrence of some species new to this country.* By Frederick Currey, Esq., M.A., F.L.S.

The object of the present communication is sufficiently described in the title given above. Being the result of a number of observations made at various times, the paper may appear to some extent discursive and unconnected, but I venture to hope that the facts recorded will be considered of some scientific value. Such of the subjects as required illustrations to render the discussion of them intelligible, are figured in the accompanying plate from drawings made (with the exception of figs. 42, 43) with the Camera lucida.

Helminthosporium Smithii. (B. and Br., 'Annals and Mag. of Nat. Hist.,' s. 2, vol. vii, pl. v, fig. 5.)—On holly, Chiselhurst, Kent, September, 1855. This is a magnificent species, and has been well characterised as the prince of the genus. It is described at length in the volume above referred to, and I notice it only with the view of recording some observations on the form and mode of germination of the spores. In the figure in the 'Annals of Natural History' the endochromes are closely united, but it is stated in the text that they are here and there surrounded by a broad cavity. Figs. 1 and 2, Pl. VIII, represent two of the spores of my specimens, magnified 220 diameters; they vary much in size; and the latter figure will give an idea of the enormous length which these spores attain. It will be seen that the endochromes vary in their degree of approximation to each other, but that each one is quite separate from its neighbour, and this was the case in all the spores which I examined. Germination takes place by the protrusion of a colourless filament from each extremity of the spore, which filament very soon forms septa in its interior, and throws out lateral branches. There is nothing more in this than has been observed in many other fungi, but it is interesting to notice that precisely the same process took place when a spore was broken into fragments. Figs. 3 and 4 represent two detached pieces of spores, which have thrown out filaments from each of their extremities, and commenced growing, just in the same way as the perfect spore. This seems to show that each portion of the endochrome has an independent power of germination, and if so it is

difficult to see in what way the spore in this case differs from an ascus, for although the spores which are produced in asci usually escape and become free before commencing germination, the contrary is by no means uncommon. I did not see any germination except from the extremities of the spores, but it is very possible that in their natural condition germs may be thrown out from the intermediate endochromes, or the whole coat of the spore may dissolve and set the separate endochromes free. What is perhaps more singular even than the germination of the fragments of the spores, is the fact that the same thing takes place with the fragments of the flocci. Fig. 5 shows two such fragments, in which processes, precisely similar to the germ-filaments of the spores, have been protruded from each extremity. It is easy to distinguish the fragments of flocci from the spores, the former having real septa, which are not to be found in the latter. The septate appearance which, according to the figure in the 'Annals of Natural History,' exists sometimes in the spores of this species, would be produced by the contact of the endochromes, and not by the existence of real partitions. It is very important, in describing the spores of fungi generally, to distinguish between real septa and those which are only apparent.

Helminthosporium fumosum. (*Dactylium fumosum*, Corda, 'Flore illustrée de Mucedinées d'Europe,' pl. xxii.)*—This interesting addition to the British Helminthosporia occurred in the neighbourhood of Blackheath, upon the dead stem of some Umbelliferous plant. It was first described by Corda in the work above mentioned, under the name of *Dactylium fumosum*, but it clearly belongs to Helminthosporium, and has no affinity with Dactylium. The flocci are stiff and erect, and, when ripe, of a very dark brown or almost black colour, being so opaque that it is a matter of difficulty to make out that they are septate. At the apices of the flocci there originate several rows of almost colourless cells, arranged in a moniliform manner, and spreading in different directions. The spores are attached in rows at the extremities of the chains of colourless cells, and are of a rich brown colour, usually somewhat narrowed at each end, and divided by several transverse lines having the appearance of septa, but which I believe to be only lines formed by the mutual pressure of the divisions of the endochromes. Fig. 6 represents three spores joined together, magnified 220

* This is the same work as the 'Prachtflora Europäischer Schimmelbildungen.' It was published both in French and German

diameters. Corda mentions the decaying stems of Umbellifers as the habitat of the plant, but adds that it sometimes grows on patches of *Torula punctata* and *Torula herbarum*. It is hardly distinguishable from *Torula herbarum* by the naked eye, but the latter has a greenish tinge under a lens which can hardly be mistaken. There were a very few spores of the latter Torula in company with my specimens of the Helminthosporium.

Botryosporium pulchrum. (Corda, l. c., pl. xix.)—This mould forms large white mealy patches upon dead or living plants, upon annuals by preference, according to Corda. I found it upon a fragment of some herbaceous plant in a rubbish heap at East Bergholt, in Suffolk, in the month of October, 1854. The flocci are very delicate, forming a woolly-looking mass, and the spores are arranged in four or five compact globular masses at the extremities of short ramuli, which are alternate upon the main threads. Corda's figure is very good, but I have not seen the tubercles upon the main flocci, to which, according to his statement, the lateral branches are articulated.

Phragmidium.—Notwithstanding the number of observations upon the Phragmidia which have been made and published from time to time, there are points connected with their anatomy and physiology upon which differences of opinion exist, and which render the genus one of especial interest to the microscopical observer. In the first place, the question of the relationship between the Phragmidia and the Uredo, with which they are almost invariably associated, can hardly be considered to be finally decided. All mycologists, I should suppose, would admit that both kinds of fruit belong to the same plant, *i. e.*, are the produce of the same Mycelium, but it seems to me to be still an open question, whether the Phragmidia represent a highly developed state of the grains of the Uredo, or whether the two productions are essentially distinct forms of fruit. M. Tulasne, in his memoir in the 'Annales des Sciences' for 1854, merely states his accordance with Unger's opinion that the transformation of the Uredo-grains into Phragmidia is inadmissible; but it cannot be denied that when a number of these fruits are mixed together it is sometimes hardly possible to say to which sort one particular specimen belongs, so delicate are the gradations by which the one kind passes into the other.*

Another question which would admit of discussion is that

* In the 'Botanische Zeitung,' 1853, p. 787, Itzigsohn suggests that the Uredo-grains are produced from the interior of the Phragmidia, an opinion which I cannot reconcile with my own observations.

of the generic distinction between Phragmidium and the allied genera Puccinia, Uromyces, Triphragmium, and Xenodochus. The number of divisions or apparent divisions of the spore affords no safe criterion, for it is not uncommon to find Phragmidium and Puccinia reduced to a single dissepiment, and the reniform shape of the so-called sporidia, which are produced by the germinating filaments of the latter, and which Tulasne mentions as a distinguishing characteristic, is not constant, as I have myself witnessed. The fruit of Phragmidium, moreover, sometimes assumes a form quite similar to Triphragmium. There is a species of Triphragnium (*T. deglubens*, Berk. and Curt.) in which the dissepiments are arranged precisely as in Phragmidium. The number of the pores through which the germinating filaments make their exit has been advanced as another ground of distinction between these genera; but here, again, there is no sufficient certainty, for Phragmidium has a variable number, and the rest have only one. These pores, moreover, are frequently, I may say usually, not discernible in the natural condition of the fruit, and only become visible upon the application of some chemical agent, which renders the epispore more transparent.

It is quite impossible to arrive at any correct notion of the anatomy of Phragmidium by examination with the microscope alone, for the fruit in its natural condition is far too opaque to admit of its structure being ascertained by inspection. The idea of the fruit consisting of sporidia united together and forming a chain is certainly not in accordance with the true structure, which will be found to approach more nearly to that of the ascigerous fungi than any other tribe. The sporidia are not united to one another in any way, but, although closely packed for want of space, they are in fact *free* in the interior of what may be called a sporangium or ascus. Perhaps the term sporidia is hardly applicable to the bodies in question, but, before discussing this point, it will be better to show what the structure of the fruit is, and the mode of ascertaining it—and the best method I find to be as follows.*

A considerable number of the spores of the Phragmidium must be scraped off with a lancet or fine-pointed knife, care being taken to scrape gently, so as to avoid tearing off the tissue of the leaf, which would interfere with the observation.

* The term "sporidia" was originally applied to the apparent *joints* of the fruit; and some confusion has been introduced by the application of the same term by Tulasne to the globular orange-coloured bodies produced in the early stage of germination, and which are noticed hereafter.

The spores must be placed on a common glass slide in a drop of alcohol, so as to drive away the air, which otherwise clings pertinaciously to the mass of spores. Before the alcohol has quite evaporated, two or three drops of strong nitric acid must be added, a piece of thin glass must be placed over the spores, and the slide should then be gradually warmed over a spirit lamp. The acid must not be allowed to boil, at least not for any length of time, because the action then becomes so powerful as to obliterate the structures which it is wished to exhibit. By following this process it will be seen that the fruit consists of an outer colourless membrane, almost transparent, which in most of the species is studded over with small tubercles, being prominences of the membrane itself. This membrane encloses a number of cells, being the cells constituting the apparent joints of the fruit, and which in their natural state are of a squarish or oblong shape, occasioned by their mutual pressure. Fig. 15 (Pl. VIII) represents a spore which has been acted on by the acid, but not to a sufficient extent to dissolve or rupture the outer membrane; which, however, has swollen and become loosened from the inner cells. When by the action of the acid the outer hyaline membrane is ruptured or dissolved, these cells escape, become detached from one another, and assume the shape shown in figs. 7 and 8.

They exhibit a broad brownish or yellow ring surrounding a central area of paler colour, and in the interior of each of these areas is to be seen, what for distinction may be called an inner cell, which in its normal form is globular, but which frequently assumes an irregular shape. Fig. 8 represents a ringed cell with its inner cell filling the whole of the cavity, and fig. 7 shows a ringed cell with an inner cell of irregular shape. I have not yet been able quite to satisfy myself as to the structure of the ringed cells. It appears at first sight as if the ring were an integral part of the cell itself, so that if the observer be supposed to be looking upon the pole of the cell, the ring would form a mass of bulging matter at its equator; but opposed to this is the fact that under the action of the nitric acid the ring sometimes entirely disappears, leaving a pellucid, globular, colourless cell, having the inner cell in its interior as shown in figs. 9 and 10. The ring is sometimes marked with concentric lines having the appearance of wrinkles in the membrane.

Fig. 11 represents an inner cell quite free, exhibiting its granular contents and a central nucleus. The inner cells have far greater power of resisting the action of the acid than the sporangial membrane or the ringed cells, for if the acid be over-

heated the membrane and the ringed cells entirely disappear, leaving only the inner secondary cells, which when free are usually globular, as shown in fig. 11. These latter cells are colourless and of a granular aspect, but have a clearly distinct membrane of their own, and are not merely the coagulated contents of the cells within which they are produced. They become of an intense brown colour upon the application of solution of iodine. Before using the above process I had ascertained the existence of these internal cells by soaking the spores in hydrochloric acid and pressing the thin glass cover, which resulted in the fracture of the coats of both the sporangium and the ringed cell, and the escape of the inner cell, as shown in fig. 13. In many of the fruits upon which the hydrochloric acid had been left to act without pressure, the pores became extended into broad circular cavities, and the inner cell protruded itself in the manner shown in fig. 14, producing an appearance which at first sight might be taken for germination.

From the above description it will, I think, be seen that the fruit of Phragmidium hardly differs from that of the ascigerous fungi. Perhaps a closer resemblance might be found in the abnormal fruits of some of the Coniomycetes, such as Hendersonia, Steganosporium, or Prosthemium, but there is little doubt that these latter fruits are themselves only modified forms of the asci of well-known fungi of a higher class. It may be as well to state, that the outer membrane spoken of above usually dissolves altogether under the action of the acid, or breaks up into fragments, which adhere to the ringed cells after their escape; but if a sufficient number of observations be made, and under different degrees of heat of the acid, some specimens will be found in which the internal cells have escaped, leaving nothing behind but the transparent outer membrane in the form of an empty sac.

The structure of the pedicel of the fruit requires a passing notice. In the 'Botanische Zeitung' for 1853, Fresenius, in criticising some figures in the 'Handbuch der Allgemeinen Mycologie,' ridicules Bonorden for speaking of a "Saft-Zelle," in the interior of the pedicel, and leaves it to be implied that such a cell exists only in Bonorden's imagination. It is strange that so accurate an observer as Fresenius should have fallen into such a mistake, for the existence of the internal cell may be demonstrated without the least difficulty by merely soaking the spores in water. Figs. 16 and 17 represent specimens of *Phragmidium bulbosum* and *Phragmidium mucronatum* treated in that manner, in which the outer membrane of the pedicel has given way,

disclosing the internal cell in the clearest manner possible. Corda, too, has figured the internal cell in his 'Icones Fungorum,' vol. iv, pl. v, fig. 70, 6 *k*; he calls it "Mark-Zelle."

The germination of the spores of Phragmidium, Puccinia, and Triphragmium, is well worth some trouble to witness. I know no microscopical objects of greater beauty than a number of fruits of Phragmidium in active germination. Tulasne was the first to call attention to it, and I am not aware that any subsequent observations have been published. I have myself seen the process in a few species, the particulars of some of which may be worth mentioning. I found (as was previously observed by Tulasne) that the fruits of Phragmidium and Triphragmium would not germinate in the summer in which they were produced, but I think further observations are necessary before it can be assumed that this is invariably the case. If, however, the fruit be taken from leaves which have either lived, or fallen and lain on the ground, through the winter, and be placed in water and kept in a moist atmosphere, there is no difficulty in producing germination. Long tubular filaments are produced from the different cells, which attain a length of four or five times that of the fruit. These filaments have a small quantity of granular orange-coloured matter, which usually accumulates towards the extremity. At the end of these filaments septa are found, varying in number, but not exceeding four, and dividing the extremity into as many small joints, each of which protrudes a small spicule or sterigma, the apex of which expands into a globular cell, into which the orange-coloured endochrome passes. These globular cells (which Tulasne calls sporidia) eventually fall off, and commence germination on their own account. Figs. 18 and 19 represent two fruits of *Phragmidium bulbosum*, the germ-filaments of which have already produced their sporidia. Two of them have each produced two sporidia, one of them has produced three, and the other four. These sporidia are of a brilliant glittering orange colour, which, contrasted with the transparent filaments and the rich dark brown of the fruit itself, produce a combination of colour which is very striking. Fig. 20 represents a sporidium which has fallen off, and commenced germination by throwing out two filaments, one of which exhibits lateral protrusions which seem to be the commencement of branches.

With regard to the germination of the Pucciniæ, which in substance is very similar to that of Phragmidium, I have noticed two instances of departure from what Tulasne considers to be the rule. I understand his opinion to be that

the sporidia of Puccinia are always distinguishable from those of Phragmidium by their reniform shape, and that the germ-filament of the upper cell of Puccinia always makes its way out through the apex of the fruit; but I have seen *Puccinia graminis* produce globular sporidia as shown in fig. 21, and I have seen the germ-filament of the upper cell of *Puccinia Lychnidearum* make its way out at the side of the upper cell, as shown in fig. 22, instead of through its apex.

The germination of Triphragmium is described by Tulasne as precisely similar to that of Phragmidium, but in the only instance in which I have succeeded in procuring germination in the former plant it took place in a manner somewhat different, and which I have drawn in fig. 23. The filament grew to a considerable length, and formed four septa at its extremity; no sterigmata or sporidia were produced, but the orange-coloured endochrome became accumulated in each of the four terminal cells in the form of two globular masses, as shown in fig. 23. One of the four terminal oblong joints fell off, and commenced germination, as shown in fig. 24, and it was obvious that the remaining three joints were on the point of becoming separated from one another.

In illustration of the gradation from the fruit of Uredo to that of Phragmidium, and of the close resemblance between Phragmidium and its allied genera, I would here call attention to figs. 25 to 33; they all represent different forms which I found in the fruit of the same specimens of *Phragmidium potentillæ*. Fig. 25 represents the normal form of the Uredo; figs. 26 and 27 show the commencement of the formation of a division which becomes complete in fig. 28. Fig. 29 is quite undistinguishable from an Uromyces, as is fig. 30 from a Puccinia, and figs. 31 and 32 might well be taken for fruits of Triphragmium, and if seen apart from the others could not be named with certainty. Although the fruit of Triphragmium has usually only three divisions, it is by no means uncommon to find four. Fig. 33 shows the perfect normal form of fruit of this species of Phragmidium.

In the fruits represented by figs. 25 to 28 the colour was the bright orange of the Uredo; in the rest, the colour was the usual dark brown of the Phragmidium. I may here observe that the spines or prominences seen in the Uredines which accompany the Pucciniæ, and which have been advanced as a mark of distinction between the two kinds of fruit, exist, I believe, only on the surface of the endosporium. I have frequently noticed that these Uredo grains, although at first sight truly echinulate, are surrounded on the exterior by an extremely delicate and perfectly smooth membrane.

This membrane is not visible unless the edge of the spore be exactly in focus. Mr. Busk, without my having called his attention to it, noticed the existence of this membrane in some spores of the Uredo of *Puccinia pulverulenta* which I sent to him, and thought that he could perceive a slight blue tinge in it upon the application of iodine and sulphuric acid.

Xenodochus carbonarius, Schlecht.—This plant, first observed by Schlechtendal, and described by him in the 'Linnæa,' vol. i, p. 237, pl. iii, is mentioned in the 'Annals of Natural History' to have been found by Mr. Churchill Babington, in Leicestershire, and I have received specimens of it from the Rev. A. Bloxam, but it seems to be of rather uncommon occurrence. It has been found only on the leaves of *Sanguisorba officinalis*, and was formerly supposed to be parasitical upon *Uredo miniata*, in company with which it grows. There can be little doubt that the Uredo, like those of Phragmidium, Puccinia, &c., is the produce of the same Mycelium as the Xenodochus itself. The fruit forms little black tufts, which differ in no respect to the naked eye from the tufts of Phragmidium. One of these fruits, in its natural state, is represented in fig. 34, magnified 220 diameters. If treated in the manner mentioned above, with regard to Phragmidium, it will be found that their structure differs in no respect from those of the latter plant. It will be seen that each consists of a clear outer membrane, enclosing a multitude of ringed cells, each of which latter cells has another cell in its interior, which under the action of the acid is set free, and exhibits a well-defined, circular nucleus. There is, in fact, no difference between Phragmidium and Xenodochus, excepting the number of the ringed cells of the latter, unless there be a difference in the number of the pores, which, however, would be a very unsatisfactory ground of generic distinction. In fig. 34 is seen a bead-like row of cells proceeding from one of the upper joints of the Xenodochus, and which appeared after the fruit had been kept in water for some hours. I do not suppose this to be the normal mode of germination of Xenodochus, for it is hardly likely that its germination should differ materially from that of Phragmidium, Puccinia, and Triphragmium. Small cells of the nature of those forming the beads in fig. 34 are sometimes given out by the spores of fungi, and the process is perhaps analogous to that which takes place in some of the lower fresh-water Algæ. In some spores of Spirogyra, for instance, which I gathered in the month of March last year (1856), and kept by me to watch their germination, although many of them, when the proper time arrived, became green and threw out their regular germs, there were many in which the contents became trans-

formed into small, globular, colourless cells; and I have seen the contents of one of the large orange-coloured spores of *Volvox aureus* become transformed into six rather large, globular, colourless cells, which floated about in a mass of coloured endochrome, being the remains of the contents of the parent-cell. In fig. 46 I have drawn a spore of *Sphæria amblyospora*, which I observed to throw out a number of these small cells into its own gelatinous envelope, whilst the regular mode of germination in this Sphæria takes place by the emission of long branched filaments, very similar to that of its ally, *Steganosporium cellulosum*, figured in vol. iv of this Journal, Pl. XI.

Gymnosporium (*arundinis?* Corda).—I am doubtful whether the plant here referred to is Corda's *Gymnosporium arundinis*. It forms small black spots on the stems and leaves of *Phragmites communis*, and is of very common occurrence, although not, I think, described amongst the British Fungi. It is possible that it may be only an imperfect state of some ascigerous fungus, but I mention it here for the purpose of calling attention to its germination. Fig. 35 will show the manner in which the spore opens by the swelling of the inner membrane. The epispore bursts, and is sometimes carried out on each side, as in figs. 35 and 36, or it bursts on one side only, as in fig. 37, where it has the appearance of a bivalve shell opening on a hinge. The protrusion of the germ-filaments was accompanied by the emission of minute staff-shaped bodies, such as are represented in figs. 35, 36, and 37. It may perhaps be objected that these bodies were not connected with the fungus, but were developed in the water in which the spores were placed, and I was at first doubtful whether this was so; but their position with regard to the germinating spores, the very short time in which they made their appearance, and the fact of their having occurred in several other instances (to one of which I shall call attention presently) in the immediate neighbourhood of germinating spores, and their non-appearance in water containing spores in which no germination has taken place, are facts which lead me to think that the bodies in question are connected with germination, and I have therefore thought it worth while to mention their occurrence with the view of directing the attention of other observers to a fact which may be of physiological importance.*

Peziza aurantia, Pers.—In this very common Peziza, I have noticed what I take to be a kind of germination, and

* In one or two instances I have seen a distinct wriggling motion in these small bodies, quite different from Brownian motion.

which is probably of the same nature as that observed by Tulasne in *Bulgaria sarcoides, Peziza bolaris, Peziza Cylichnium, Peziza tuberosa,* and *Peziza vesiculosa.* It consists in the formation of minute spherical or subspherical utricles on the surface of the spore, and which Tulasne has called sporogenous spermatia. The bodies observed by Tulasne were sometimes (in *Bulgaria sarcoides,* for instance) upon the exposed endosporium, sometimes upon short tubular appendices; sometimes they had very short pedicels, and sometimes they were sessile; they were sometimes joined together in rows, sometimes in bunches, but were more frequently solitary, and they were often produced successively, *i. e.,* as one of them dropped off another supplied its place, until the power of the spore was exhausted. In the spores of *Peziza aurantia,* to which I have referred, similar utricles were produced, but they were all sessile upon the surface of the *inner membrane* of the spore, and in many of the spores the outer membrane (although extremely thin and fine, and easily to be overlooked) was sufficiently discernible upon a careful examination, entirely enclosing the utricles. In fig. 39 are shown three of the spores of *Peziza aurantia* in their usual form, as they appear in the interior of the asci, magnified 315 diameters; and fig. 38 shows three of the same spores after they have escaped from the asci, and lain some time upon the surface of the hymenium, and commenced the process above-mentioned. In some cases, the growth had taken place before the escape of the spores from the asci. In some of the spores, the utricles produced at one extremity or pole were somewhat longer than those in the other positions. The spores of *Peziza aurantia,* as of those of several allied species, are elliptical, and there are almost invariably found two globular nuclei, or oil drops, of equal size, occupying the two foci of the ellipse. In those spores in which the above growth had taken place, the nuclei were less distinct than in those in which no change had occurred, and in some instances the two nuclei had broken up into several; the spores also had increased in size. This is just what Tulasne noticed in *Peziza vesiculosa,* for he states that in that plant the spores which produced a Mycelium, as well as those which he calls the spermatophorous spores, increased in size sensibly before vegetating, and that their oily contents lost at the same time their homogeneity and assumed a granular aspect. There was another remarkable circumstance connected with this change of form and germination in the spores of *Peziza aurantia,* and that was the contemporaneous appearance of an enormous mass of minute staff-like bodies, precisely similar to those mentioned above as occur-

ring during the germination of *Gymnosporium arundinis*. I did not ascertain as a fact, but I suspect, that these small bodies were produced from the interior of the germinating spores; and if this be so, it is not impossible that they may be possessed of some fecundative power; for although there has lately been, perhaps, too great a tendency to consider every small unaccountable vegetable organism as connected with impregnation, still, with what is now known with regard to the Algæ, and what is suspected in the lichens, it is not unreasonable to suppose that the male sexual organs of fungi, if they exist, will prove to be of a nature somewhat similar to the bodies just mentioned.

Triposporium (sp.?)—In fig. 40, I have drawn the fruit of a Triposporium, which occurred in January, 1855, near Bexley, in Kent, upon a small fallen branch. It differs from *Triposporium elegans* in the colour of the threads and spores, which are olive brown, with a tinge of green, and much darker to the naked eye than those shown in Corda's fig. in the 'Flore Illustrée,' tab. x. The branches of the filaments also do not exhibit the bulbous enlargement at the base which is so peculiar a feature in *Triposporium elegans*. Mr. Berkeley, who, at my request, kindly examined one of my specimens, thought the plant was *Triposporium Ficinusium*, which is figured in Sturm's 'Deutschlands Flora;' but the spores of *T. Ficinusium* are of a somewhat different colour, and are not so much elongated, as will be seen by comparing fig. 40 with the plate in Sturm's work. (See Abt. iii, Heft 30, fig. 8.) I may observe that the tufts of my Triposporium are accompanied by a vast number of the perithecia of some Sphæria, the perithecia being surrounded by and embedded in the threads of the Triposporium. It is probable that the spores of the latter may be only a secondary product of the Mycelium of the Sphæria. Unfortunately, the perithecia are barren, so that I have been unable to ascertain the species of the Sphæria.

Clonostachys araucaria, Corda, 'Flore Illustrée,' tab. xv. p. 31.—I have found this mould in my own neighbourhood and also in Wales, in both instances forming white patches upon the bark of small twigs. It is remarkable for the peculiar arrangement of the spores, which form long dense spikes like ears of corn. It is figured also in Bonorden's 'Handbuch,' pl. vii, fig. 155, under the name of *Stachylidium araucarium*. Corda's specimens appear to have grown upon garden mould, but his description of the habitat is ambiguous.

Zygodesmus fuscus, Corda, 'Einleitung,' pl. B. 8, fig. 1; 'Icones Fungorum,' vol. iv, fig. 81.—I have found this mould near the Hassock's Gate Station, on the Brighton Railway, and

also in the neighbourhood of Tunbridge Wells, upon the bark of fallen branches; it is easily recognised by the reddish-brown colour of the filaments, and by the echinulate spores, but I have found it difficult of observation from the densely tangled mode of growth of the flocci. The structure is not always such as is represented in Corda's figures, where the spores are borne singly upon the tips of short filaments proceeding from the main flocci. I have distinctly seen three sterigmata produced at the apex of a fructifying thread, and the latter was of some length, and slightly swollen at the apex, not a short, stiff, pointed thread as in Corda's figures. Fig. 41 represents a fertile thread, magnified 220 diameters, and by the side of it are shown three spores similarly magnified. The fertile threads sometimes, I think, produce four sterigmata.*

Coryneum Kunzei, Corda, 'Icones Fungorum,' vol. iv, taf. x, fig. 151.—On oak, Shooter's Hill Wood, autumn, 1853. Corda distinguishes this species from all other Corynea by the nature of the epispore, which he states to be *continuous*, whereas, in the other species, he considers the fruit to consist of a number of distinct cells united together. I have, unfortunately, mislaid my specimens, and am unable to test the accuracy of Corda's views of their anatomy, but I suspect there is no real difference in structure between this and the other species. *Coryneum Kunzei* is stated by Corda to be very rare, and I do not know that it has occurred in England except in the above locality.

Trichia cerina, Ditmar.—Peridium ovoid, of a greenish yellow colour; stem elongated, fuliginous; sporidia globose, colour of the sporidia and capillitium the same as that of the peridium. (Ditmar, in Sturm's 'Deutschlands Flora,' t. xxv, p. 51. *Trichia clavata, β. olivascens*, Fries, 'Syst Myc.,' iii, p. 186.) On wood, Sketty, near Swansea, September, 1855.

My specimens accord well with Ditmar's figure and description. Fries considers the plant as only a variety of *Trichia clavata*, but the latter has a yellow shining peridium of a very different appearance. There is also a marked difference in the spiral threads. In *Trichia cerina* the threads are pale coloured, and taper gradually to a very thin point at each extremity; the spiral markings are very delicate, and the threads themselves are simple, detached from one another, and of a definite and moderate length. In *Trichia clavata*, on the other hand, the threads form an extensive complicated

* Mr. Berkeley thinks it possible that the species of Zygodesmus may be conditions of certain Thelephoroid Fungi. See 'Introduction to Cryptogamic Botany,' Bailliere, 1857.

capillitium, in which it is rarely (if ever) possible to trace a single thread from one extremity to the other, and their colour is darker. The markings also are strongly defined, and altogether very different from the very delicate ones of *Trichia cerina*.

Trichia nigripes, Fries, 'Syst. Myc.,' iii, p. 186.—Gregarious, peridia various in form, even, yellowish; stem very short, blackish; capillitium and sporidia of a yellowish ochre. Near Eltham, Kent, and near Weybridge, in Surrey; common.

This species, as Fries has remarked, is closely allied to *Trichia varia*—indeed, the elaters of the two are (generally speaking) not distinguishable. The peridia, however, of *Trichia varia*, are considerably smaller, of a brighter yellow, and frequently assume a reniform shape, which I have never found to be the case with *Trichia nigripes*. The stem of the latter varies much, and is sometimes quite obsolete. In all the specimens which I have found the peridia are uniformly ovoid, and the lower part when empty has the transparent, shining, skinny appearance noticed by Mr. Berkeley in *Tr. clavata*. I have figured the elaters of this species, in a paper on those organs, in the 3d vol. of this journal.

Trichia rubiformis, Pers.—Weybridge, January, 1856.

Some confusion seems to exist between this plant and *Trichia Neesiana*. The two are figured side by side in Corda's 'Icones Fungorum,' vol. i, taf. vi, 288 B, 288 C, and are, at first sight, very different in appearance. The threads of the former are represented as being smooth, and those of the latter as strongly echinulate. The *peridia* in the Weybridge specimens exactly resemble fig. 288 B, but the threads are completely covered with spines. I cannot help thinking that Corda has figured the threads of some other species by mistake, for, in his previous memoir, 'Ueber Spiral-faser-zellen,' he has represented the threads of *T. rubiformis* as spinous. It is true that there are some Trichiæ in which the threads, although usually smooth, exhibit occasionally a few spines, but I have never found the extremes of roughness and smoothness united in one species, as must be the case if Corda's figures be correct. There are specimens marked *Trichia Neesiana* in the Hookerian Herbarium, which, through the kindness of Sir William and Dr. Hooker, I have had an opportunity of examining, and the threads are quite undistinguishable from those of *T. rubiformis*. The peridia in the Kew specimens are, unfortunately, in an imperfect condition, but they appear to have been stemless, like those in Corda's fig. 288 C. It is to be observed that the peridia of *T. rubiformis* do not always grow in a fasciculate manner, and the only difference between detached specimens of *T.*

rubiformis and *T. Neesiana* is the absence of a stem in the latter species, a difference hardly sufficient to justify their separation, when it is considered that the broad expanded form of the base from which the peridium springs is common to both species. It is probably therefore right that the two should be united under one species, as was suggested some time since by Messrs. Berkeley and Broome, in the 'Annals of Natural History.'

Trichia Lorinseriana, Corda, 'Ic. Fung.,' vol. i, p. 23, taf. vi, 288 D.—Subsolitary; stem long, of a dirty brown colour, flexuous and furrowed, the ridges between the furrows being sharp edged; peridium turbinato-ovate, smooth above, bursting irregularly or in an operculate manner; spiral threads short, very pale yellow, with very delicate markings, each extremity of the thread tapering gradually to a very long, thin point, the spiral markings not extending into the narrow extremities of the threads. Weybridge, January, 1856.

The above description differs slightly from that in the 'Icones Fungorum,' but I see no reason to doubt that my specimens belong to the species there described. The spiral threads are simple and detached, very similar to those of *Trichia serotina*, from which they differ only in being considerably longer.

With regard to the spiral threads of the British Trichiæ, generally, I may observe that their form, colour, and microscopic structure afford material assistance in the distinction of species: those of *T. nigripes, pyriformis, chrysosperma, serpula*, and *Neesiana* (or *rubiformis*) are figured in vol. iii. of this Journal, Pl. II. The only other British species which have not been already referred to are *Trichia fallax, varia*, and *Ayresii*. Those of *Trichia varia* are not distinguishable from the same organs in *T. nigripes*, but I have found *T. varia* with echinulate threads; and the same thing occasionally occurs in *T. chrysosperma*. I have had no opportunity of examining *T. Ayresii*, but the threads are described as tawny and strongly echinulate. Specimens of *Trichia fallax* exist in the Hookerian Herbarium, but they have been gathered young, before the formation of the threads, and I have seen no other specimens.

I noticed on a former occasion that in *Trichia pyriformis* the membrane of the threads had the property of unrolling itself in a spiral manner, a peculiarity which is still more manifest in *Trichia clavata* and *T. turbinata*. In some threads of the latter which had been soaked in hydrochloric acid, I found that the tube of the thread had burst in several places by a perfectly smooth spiral fissure, thus converting the tube

for short distances at the points of rupture into a flat band, which was seen to be traversed by five bright narrow lines, running longitudinally in the manner shown roughly in fig. 42. These are the markings which Mr. Henfrey has explained as arising from the deposit of a spiral fibre, but which seemed to me to be caused by a ridge in the membrane. I should certainly mistrust my own opinion when opposed to Mr. Henfrey's; but Mr. Busk, who carefully examined some specimens of the threads, has stated to me his decided opinion against the existence of any fibre. The editors of the 'Micrographic Dictionary' have objected that a ridge round a tube is a structure unknown in the vegetable world, but circular ridges were observed by Mr. Berkeley, some time since, in the capillitium of *Arcyria umbrina*, and longitudinal ridges have been noticed by M. Trecul in the vessels of *Impatiens fulva*. The fact of the ridge taking a *spiral* direction can hardly be of importance, more particularly when it is considered that with reference to the narrow band of membrane, by the twisting of which (in some species at least) the threads are formed, the ridges are, in fact, longitudinal. Pringsheim describes the outer coat of the spores of *Sphæroplea annulina* as covered with ridges running, as it were, in meridian lines from pole to pole of the spores.

Trichia ?—On very rotten fir wood, at Weybridge, Surrey, January, 1856.

This is a plant of which the generic position is somewhat doubtful, but it comes nearer to Trichia than to anything else, and as I have only once found it, it will be better perhaps to place it, provisionally at least, in that genus. It differs from the known species of Trichia in the shape of its peridium (which alone would not be of much importance), and in its capillitium. The peridium is globular, of a dull tawny colour, and supported upon a comparatively long stem; the shape will be seen by a reference to fig. 43, which shows two specimens of the fungus slightly magnified. The spores are yellow and globose, and about half the size of the spores of *Trichia chrysosperma*. The capillitium consists of a mass of reticulated threads, not having the usual spiral markings peculiar to Trichia, but spread out at short intervals into broad membranous expansion, the latter having a chequered appearance, somewhat like that of the scalariform vessels in other plants. I am not certain whether these expansions are formed of a single layer of membrane, or whether they are hollow sacs, but I rather think the latter. Fig. 44 shows a fragment of the capillitium, which bears a slight resemblance to the capillitium of *Lycogala terrestris*,

figured by Corda in his 'Icones Fungorum,' vol. vi, taf. ii, fig. 37; but Corda states that the markings in the Lycogala are caused by wrinkles in the membrane, which is not the case in the present plant. It has occurred to me that this fungus may be a true species of Trichia, in which the development of the capillitium has been arrested. I have not had an opportunity of tracing the growth of the spiral threads of the Trichiæ from the state of mucilage in which the plants originate; but in Didymium, I have observed that the commencement of the formation of the capillitium regularly takes place by the drawing out of the mucilage into threads, which threads at first are always expanded at moderate distances into broad membranous spaces precisely similar in form to those in fig. 44; and if the subsequent growth were stopped at that period, the capillitium in Didymium would exactly resemble in form (although not in colour or marking) that of the above plant.

Trichia ?—Glen Alla, near Lough Swilly, County Donegal, Ireland.

This is another doubtful species, for which, as for many other interesting objects of natural history, I am indebted to Miss Wilcox, of Tenby. The peridia are sessile, crowded, subglobose, and of a dull brownish-yellow colour, looking like very small stunted specimens of *Trichia chrysosperma*. The peculiarity of the plant consists in the total absence of capillitium or elaters. The spores are small and subglobose, forming a dull yellow dust in the interior of the peridia. It might be a question, whether the absence of the internal threads would justify its separation from Trichia. Fries, who treats the elaters as secondary appendages of no importance, would probably say not. At all events no such separation could be made upon the faith of the one small specimen in my possession, in which the growth of the capillitium may from some unknown cause have been suppressed.

Ophiotheca chrysosperma.—Under this name I described a new fungus in vol. ii of this Journal, and stated the points of distinction between it and the genus Arcyria, one of which was the existence of a capillitium consisting of two kinds of threads. Since that paper was published, I have found at Sketty, near Swansea, a very minute Arcyria, not belonging to any of the British species hitherto described, and which exhibits a double capillitium of a precisely similar kind. This reduces the difference between Ophiotheca and Arcyria to the single point of the shape and dehiscence of the peridium, and whether this would be sufficient to keep the genera apart, I must leave for others to determine.

Choiromyces meandriformis, Tul. *Rhizopogon meandriformis*, Corda. *Tuber album*, Sow.—A single specimen of this very rare truffle occurred in my own garden, at Blackheath, in the month of November, 1855. I believe only one other specimen of it has been found in England since Sowerby's time, and that was by Mr. Broome, in Marlborough Forest. Mr. Berkeley tells me he has an authentic specimen of Sowerby's *Tuber album*, and that it is the same plant. My specimen was found near the surface, in a somewhat stiff soil, very near the roots of a walnut tree, and in a spot where but few rays of the sun can ever penetrate, and those only for a very short time in the day. It is possible that other specimens may have been destroyed, as the ground for a considerable space within two feet of the spot had been dug out to a depth of several feet for repairing the foundation of a wall. With the exception of this disturbance the ground had not been moved for years, being in a part of the garden where it was impossible to induce anything to grow. A description of this plant is to be found in Tulasne's 'Fungi hypogæi,' and in the sixth vol. of Corda's 'Icones Fungorum.' The spores are globular and covered with sharp excrescences. Fig. 45 represents an ascus with spores magnified 220 diameters. The ascus figured contained only six spores, but the usual number is eight. The spores are of a pale yellow colour. I made a careful search last autumn (1856), in the hope of finding more specimens, but without success.

Claviceps purpurea, Tul., 'Annales des Sciences naturelles,' ser. 3, vol. xx, p. 45. *Sphæria purpurea*, Fr. S. M., ii, 325, &c.

Claviceps microcephala, Wallr., &c.

These two plants, of which the synonyms are too numerous to mention here, have not hitherto, as far as I am aware, been found in their natural state in this country, although they must be of frequent occurrence. They are the ultimate produce of the ergot of rye and other grasses, and the former (*Claviceps purpurea*) has been grown artificially by Messrs. Berkeley and Broome, by sowing the ergot of rye in common garden mould. I have myself procured the growth of the former (*Claviceps purpurea*) sparingly, and of *Claviceps microcephala* abundantly, by merely keeping the two kinds of ergot in a continually moist atmosphere. The nature of ergot, as is well known, had been for many years a subject of discussion, and the views of botanists with regard to it were apparently tending to the opinion in favour of its being a diseased state of the grain of the grasses in which

it occurs, when the matter was taken up by M. Tulasne, who in 1853 published the result of a vast number of observations, and came to the conclusion that the systematic position of the ergots was amongst the Sclerotia, in which they had been placed by De Candolle. According to Tulasne's views, the ergot, although usually causing abortion in the ovary, is quite unconnected with the fruit of the grass attacked by it, and is in fact only a compact Mycelium (*Mycelium condensatum*), which after lying dormant for some months produces eventually a species of Claviceps. He found the *Claviceps purpurea* produced uniformly by the ergot of rye, and *Claviceps microcephala* by the ergot of *Phragmites communis*. In the 'Botanische Zeitung' for February 2d, 1855, Cesati, in a paper on the Nature of Sclerotium, mentions the occurrence of *Claviceps purpurea* upon the *ergot of Phragmites*, and seems to think that this fact throws considerable doubt upon Tulasne's theory. He says,—"Je prie de vouloir bien remarquer ce fait contradictoire a mon avis primitif sur la signification des Sclerots et qui leur ôte davantage l'importance du rôle assigné par M. Tulasne. La même espèce d'ergot serait la base de deux Claviceps fort differens."

I can myself confirm the occurrence of *Claviceps purpurea* on the ergot of Phragmites, for early in last summer (1856) I found a panicle of the previous year of *Phragmites communis* full of ergot, the ergot itself being covered with specimens of *Claviceps purpurea*, without a single specimen of *Claviceps microcephala*. The question then arises how far this fact is consistent with Tulasne's theory, and I confess there seems to me to be considerable difficulty in reconciling the two; although there is the great weight of Mr. Berkeley's opinion on the other side. Mr. Berkeley, in defending Tulasne's doctrine, says—"It is possible that the sporidia of two species of Cordyceps (Claviceps) may be equally capable of affecting the grain of the same grass, though the ergoted grains arising from the action of the two species may not be distinguishable; and even supposing that at one and the same time the ergot might produce *Claviceps purpurea* and *C. microcephala*, no reason can be adduced why the sporidia of either species should not concur in the production of the ergot." From the mention of *ergoted grains*, it would seem that Mr. Berkeley considers the ergot and the grain as in some way connected in growth, and if this were so no doubt the difficulty would be got over, for the same grain might easily harbour the latent Mycelium of the two species of Claviceps, but the essence of Tulasne's theory is that the

ergot is a body unconnected with the ovules of the grass, taking its rise at the bottom of the cavity of the spermatogonium of the Sphacelia or fungoid growth, which is the first symptom of the disease. The difficulty might be got rid of by supposing the ergot to be a compact mycelium of a compound nature, formed by the sporidia of both species of Claviceps concurrently; but the mode of origin of the ergot in the interior of the spermatogonium renders this supposition impossible, except upon the assumption that the spermatogonium itself is formed by the sporidia of both species, and this can hardly be considered probable. The only explanation consistent with Tulasne's theory seems to me to be, that the ergot of the Phragmites, which produces *Claviceps purpurea,* and the ergot of the same grass which produces *Claviceps microcephala,* are *essentially* although not *perceptibly* distinct; and that the ergot of Phragmites producing *Claviceps purpurea* is identical with the ergot of rye, but modified in size by growing upon Phragmites instead of upon rye. It is obvious that this explanation would fail if the two species of Claviceps should be found upon the same identical specimen of ergot, but I am not aware that this has ever been observed. I do not understand from Cesati's statement that the two species were produced contemporaneously, and such was not the case in the specimens which I found in my own neighbourhood.

BLACKHEATH PARK, S.E.;
February, 1857.

On the presence of SILICA *in the* RUBIACEÆ *and in* ACHILLEA PTARMICA. By ADOLPH LEIPNER, Esq.

(The substance of this paper was read to the Bristol Microscopic Society, January 14th, 1857.)

AMONGST the various inorganic elements which we find present in plants, there is hardly one more interesting than silica, either to the amateur microscopist or to the truly scientific botanist. Some microscopic preparations of siliceous parts, obtained from the Equisetaceæ, Gramineæ, from the *Deutzia scabra,* and some other plants in which it has been discovered, are rarely wanting in the limited collection of the tyro, whom they please,—and never, I may say, in the cabinet of the experienced physiologist, whom they still, to some extent, puzzle.

The simple fact of the presence of silica in these plants has

long been known, its position defined, and its quantity determined. It might at first sight appear unnecessary to lay much stress upon the existence of silica in a new order of plants, when we already have the two orders above named affording such abundant examples of its presence, but there are two points of interest in this manifestation of it.

1st, that as yet, so far as I am aware, the presence of silica has not been noticed in any indigenous exogens, and

2dly (which is of more importance), that the silica exists in such small and varied proportion, as to offer vastly superior opportunities for investigating its mode of deposition.

In the Gramineæ and Equisetaceæ the silica occurs chiefly in the epidermis, where it exists in the form of a siliceous tissue, exhibiting all the details of the epidermis, the outlines and exact form of the epidermic cells and stomata; and enters, moreover, into the composition of all the various structures which are developed from it, such as spines and hairs. After having destroyed all organic matter, either by burning, or, what is still better, by boiling in nitric acid and subsequent charring, we therefore still retain the epidermic structures in the form of what might be called a siliceous cast.

With regard to the Rubiaceæ, I have to make the same remark, viz., that it is chiefly, if not solely, in the epidermis that silica exists. But in order to define its exact position, it will be desirable to recall attention to the structure of the epidermis, and the first formation and after-development of the vegetable cell.

The epidermis consists of two organs, the cuticle and the true epidermis.

The cuticle, which, according to the present opinion of most botanists, is present in all plants, is a thin, colourless, transparent membrane, which overlies the true epidermis, and is in general considered to be a secretion from the outside of the epidermic cells below it. Only the stomata are not covered by this membrane.

Underlying the cuticle is the true epidermis, consisting of one or more layers of flattened and compressed cells. In the order before our notice, the outlines of these cells are all flexuose, the stomata occurring at intervals between them, but only on the under side of the leaves and near the angles of the stem.

It is in the underlying or true epidermis, that the silica occurs not only in the Rubiaceæ, but also in the Gramineæ and Equisetaceæ. But on observing an individual cell, whether epidermic or not, and examining its first formation, its growth and completion, we notice at first a simple vesicle,

formed by a transparent membrane, composed of pure cellulose, an unazotized substance of $2\,(C_{12}\,H_{10}\,O_{10}) + HO$. This membrane is permeable by fluids, not by means of pores, but by the process of endosmose. The interior is occupied with mucilaginous matter, the "protoplasm" of Mohl, which is at first homogeneous, but assumes by degrees a granular appearance, and forms ultimately a layer on the inner surface of the original cell, denominated by Mirbel and others the "primordial or internal utricle." By successive layers on the primordial utricle, the mucilaginous contents of the cells form all the various secondary deposits, which are frequently arranged spirally; but as this process of thickening by deposition advances, the original cell-wall itself becomes finally united with the secondary deposits.

With regard now to the siliceous deposits in cells, it must be remarked, *in limine*, that according to the opinion of all physiologists the original cell-membrane is never composed of anything but pure cellulose; the silica must therefore take, as it were, the place of the secondary cell-membrane and cell-deposits. It is true, that by decarbonizing a siliceous epidermis, either by chemical means or by burning, we obtain a perfect membrane or tissue, in which the cells are all attached to each other; but this does not prove, that the silica entered into the composition of the original cell-membrane; it merely proves that the secondary deposits have, as I before stated, united in their more advanced stage with the primary cell-walls. That this is actually the case, my own observations of the epidermis of canes and straw seem to verify. For by continuing the action of chemical agents, I have observed that the cells separated; from which I have inferred that the cellulose membrane between the individual cells, or in other words the primary cell-wall, had been at length destroyed, which no doubt would have taken place before, had it not been so intimately blended with the secondary siliceous deposits.

So far most physiologists I think pretty well agree; but when we come to inquire further: "What is the relative position of silica and organic matter in the cells? and what is its mode of deposition?" we meet either with very conflicting opinions, or with the most indefinite ideas.

It thus happens, that though I have taken much pains to consult the writings of such eminent botanists and physiologists as Lindley, Henfrey, Balfour, Quekett, and my fellow-countryman Schleiden, with others, I have not been able to meet with even a clearly expressed theory upon this interesting point.

I have already referred to the small and variable quantity of silica present in the Rubiaceæ, and propose to take advantage of this peculiarity in further investigations, by which I hope to arrive at more positive conclusions upon the vexed question of the nature of siliceous deposits; whether they obey the ordinary laws of inorganic bodies, and are simply deposited from the secretions in the manner of *raphides*, as Schleiden appears to think, or whether they are deposited *pari passu* with organic atoms as an integral part of the cell-growth, and in conformity with organic development. In confirmation of the latter supposition, I may here slightly advert to a peculiarity which I have noticed in treating siliceous membranes with nitric acid. If the action is maintained only so long as is required to destroy the adhering organic substances, a siliceous membrane perfectly homogeneous in its structure is presented; but if this membrane be further treated with nitric acid, it loses its homogeneous appearance, and seems to be studded all over with small granules, and the more so the longer it is boiled in the acid. This can be better seen by changing the focus, as some of the granules are more deeply imbedded in the membrane than others.

In concluding this communication I may state that I have found silica in every one of the four genera of which the British Rubiaceæ are composed, viz., *Rubia, Galium, Sherardia,* and *Asperula;* in fact, although I have examined all indigenous plants of this order, with the exception of *Galium pusillum* (L.), *G. erectum* (Huds.), and *G. Vaillantii* (D. C.), I have failed to distinguish the silica-deposit only in *Galium cruciatum* (L.) In all of the others, I have found siliceous epidermic tissue in the stem as well as in the leaves, which depolarizes light if it is present in sufficient thickness; this is especially the case in the prickles, which all these plants have at the margin of the leaves and the angles of the stem. I have also detected it in the cotyledon-leaves of *Galium mollugo* (L.), the only species in which I have examined this organ.

That the Rubiaceæ are not the only exogenous order in which silica is to be sought will appear from the fact, that I have also found it in *Achillea ptarmica* (L.), one of the Compositæ. This plant, which bears the popular name of "sneeze-wort yarrow," possesses a particularly large amount of silica in the prickles forming the sharp double serratures of the leaves, which is doubtless the cause of its errhine properties when powdered and used as snuff.

On the Zoological Position *of* Dysteria.

By P. H. Gosse, F.R.S.

During my stay at Tenby last summer, I had some opportunities of studying the new and singular animal *Dysteria*, the subject of Professor Huxley's excellent memoir in the January number of the 'Quarterly Journal.' While I cannot but admire the skill with which he has worked out the interior structure, some parts of which presented to my own investigations insuperable difficulties; and while, in respect to most of the details which I did succeed in resolving, I agree with him; I had, before his memoir was published, formed a different judgment as to its zoological position.

At first sight I was ready to conclude, with Mr. Huxley, that it was an Infusorium of the family *Euplotidæ;* and, indeed, long before that gentleman's allusion to the *Chlamidodon mnemosyne* of Ehrenberg, I had shrewd suspicions that our Tenby stranger might be no other than that species. The peculiar outline of the lorica, its delicate longitudinal striation, the "large, oval, bright central gland" (contractile space?), the marginal row of cilia, longer in front, playing beneath the overlapping edge of the lorica, the marine habitat, and especially the brilliant rose-coloured vesicles, are all characters (remarkable in their cumulation) which point to such an identification. It is true there are important diversities between *Chlamidodon*, as described and figured, and our *Dysteria;* but those who have been accustomed to examine minutely the figures of the eminent Prussian zoologist, and to compare them with the living animals, will not hastily pronounce their identity impossible.

Presuming *Dysteria* to be an Infusorium, it must be a species *sui generis*, with no close affinity with the *Euplotidæ*. An animal whose soft parts are enclosed between two deeply *compressed* valves, and which crawls by the aid of a hinged shelly foot, is widely different from one greatly *depressed*, covered with a dorsal plate, and whose organs of locomotion are short flexible setæ, scattered over the soft ventral surface.

But I am by no means sure that it should be placed among the Infusoria at all. Mr. Huxley observes that "the absence in an animal which takes solid nutriment, of an alimentary canal with distinct walls, united with the presence of a contractile vesicle, with the power of transverse

fission, and with cilia as locomotive organs, is a combination of characters found only in the Infusoria."*

Now the presence of a contractile vesicle, and of locomotive cilia, are quite as characteristic of the Rotifera as of the Infusoria. The absence of an alimentary canal is, I think, not proved: it seemed to me that the animal possessed a defined digestive cavity, though very ample. In *Sacculus*, —an indubitable Rotiferon, which carries its large eggs in the manner of a *Brachionus*,—the alimentary canal, without apparent distinction of stomach and intestine, is so large that it occupies fully five sixths of the whole volume of the lorica; and though it is invariably found filled with a green alga, on which the animal feeds, the walls of the digestive cavity are not better defined than in *Dysteria*. There remains then only the fact of increase by transverse fission. This, I confess, is a strong point, if well established. But it does not seem certain, from Mr. Huxley's words, whether he witnessed the progress of constriction, from an early stage, until two perfect animals were formed out of one, or only saw an individual so strongly constricted that the result seemed legitimately inferible. If the latter was the case, is it not just possible that it was an example, not of spontaneous fission, but of malformation, instances of which are frequent among the highest animals? It is highly worthy of note that the *nucleus*, so characteristic of the Infusoria, *was not found, even under careful search with acetic acid.*

The presence, position, and movements of the foot, hinged, as it is, upon a tubercle, and the form of the principal organs of manducation, seem to me to determine the place of *Dysteria* within the class Rotifera; while, at the same time, the lack of internal motion, the apparent want of distinct muscle-bands, the great extent of the vibratory cilia, and the absence of a rotatory arrangement, show that it occupies one of the vanishing points of the class.

If this allocation be admissible, it is interesting to inquire, what are the recognised forms among the Rotifera to which this animal makes the most obvious approaches. The following points of relationship occur to me:

1. The oval form and bivalve character of the lorica suggest the *Coluridæ*, with which the creature associates; but *they* have the valves separate only on the ventral edge.

2. The *Salpinadæ*, on the other hand, have the lorical plates separate down the dorsal edge, but soldered together ventrally, the foot playing in a fissure.

* Loc. cit., p. 82.

3. The excavation in the interior part of the head causes the part above it to assume the form of a hook, the point of which is downwards and forwards.

Now in the *Coluridæ*, as well as in some other allied genera, a broad frontal hook is very characteristic. It is true, that in these it is apparently articulated to the lorica, of which it forms a firm appendage, and is endowed with separate motion. In *Stephanops*, however, it is fixed and immoveable.

From these slight analogies we may perhaps link the form with *Colurus* and its allies.

But the predominance of resemblances is with another group,—that which includes *Monocerca* and *Mastigocerca*; and some of these points of similarity are the more interesting, because they are such as already isolate (though in a much less conspicuous manner) these genera from the more normal Rotifera.

1. They are single-toed; whereas the majority of footed Rotifera are two-toed.

2. Some of them are unsymmetrical; as *Mastigocerca*, in which the dorsal carina leans over to the right side, and the left series of manducatory organs is more developed than the right; and *Monocerca*, in which the right malleus is wanting, and (in some species) the antennal processes and the frontal spines are unequally developed.

3. The manducatory apparatus is of far greater comparative length in these genera than in any other known Rotifera; in *Monocerca porcellus* and *M. stylata* approaching, and in *Mastigocerca carinata*, equalling, half the length of the lorica.

4. These genera, when crawling on a smooth surface (as a plate of glass), are able to render themselves stationary, and acquire a *point d'appui* for their progression, by the curious provision of a thick glutinous fluid. This is secreted in the hinder region of the body, and thrown out in a copious stream, which may be often seen passing down the long foot like a thick entwining cord, and then left trailing behind, as the animal moves forward. Now this interesting contrivance is paralleled in the new form we are considering; for Mr. Dyster tells me that the point of the foot remains glued to the glass after death, "probably from some exudation."

From these analogies, I incline to give to this animal a place in the family *Monocercadæ*, as a very aberrant genus. I consider that it has remote relations also with the *Salpinadæ*, and especially with the *Coluridæ* (through *Monura*); and that it *is* an annectant form between the Rotifera and the

Infusoria, with a preponderance of the characters of the former class.

I propose the following generic characters for the animal:

CLASSIS ROTIFERA.

FAMILIA MONOCERCADÆ.

Genus *Dysteria* (Huxley).

Lorica bivalvis, inæquivalvis, ferè totâ margine hiante. Corporis facies capitales et ventrales ciliatæ. Apparatus manducatorius valdè elongatus, in mastace dignoscenda non inclusus. Cavitas digestiva amplissima, simplex. Pes inarticulatus, indivisus, spathulatus, compressus.

Sp. *D. armata* (Huxley). Species unica.

On COMPOUND NUCLEATED CELLS. By J. HEPWORTH, Esq.

ALTHOUGH many writers speak very positively as to the compound nucleated cell being invariably a characteristic sign of cancer, my observations for some years past have led me to doubt the truth of this. I believe it is more frequently found than otherwise; but not always.

H. J., a female, aged fifty-five years, applied to me, having an ulcer on the upper lip, which had all the characteristic signs of cancer, *except the nucleated cell.* I removed a V-shaped portion of the lip, including the disease; the parts healed, and I heard nothing more of the case until after a lapse of two years, when the woman presented herself again, with a similar ulcer on the nose; so situated, that the knife could not be used with advantage. It resisted every remedy, and gradually went on, though slowly, to a fatal termination; after destroying the nose, and dipping into the orbit.

I frequently examined very carefully the secretions from the surface, and from time to time snipped small portions from the parts; but never detected a nucleated cell; I only found pus-globules, altered blood-discs, and exudation-corpuscles.

L. T., a man, aged forty-five, died of cancer of the stomach; on examination, the greater and lesser omenta colon, and stomach were all shrivelled up into a hard scirrhous mass, the coats of the stomach were three quarters of an inch thick, the pylorus was ulcerated; although I had no doubt as to the nature of the case, I detected no nucleated cells.

There are some objects that we occasionally meet with which have some resemblance to nucleated (cancer) cells, at first sight, but on closer examination they are found otherwise; for instance, in the deposits after desquamatory inflammation of the tubuli uriniferi, the epithelial scales, when clustered together, and heaped one upon another, have somewhat that appearance (fig. 1, Pl. IX). There are other compound cells, which have not the least resemblance to the so-called cancer-cell, as fig. 2, which represents cells found in the fluid drawn from a sac in ovarian dropsy, in which there were abundance of pus globules; indeed these appear to have formed the nuclei of the compound cells. The other drawings represent *cancer-cells*, from different sources. (Fig. 3.) Cells from a cancroid tumour of the brain. (Fig. 4.) Cells from epithelial cancer of the fore-arm, of a fine old woman of eighty-three years of age; now under treatment; the axillary glands have become affected with the disease, which is progressing rapidly. (Fig. 5.) Cells from the mamma. (Fig. 6.) Cells from the uterus.

Dr. Inman's case, of Liverpool, is an excellent illustration of the "Practical use of the Microscope." If other gentlemen would publish the results of similar observations, it would lead to useful investigations by many.*

* 'Quart. Journ. Micr. Science,' vol. v, p. 20.

TRANSLATIONS.

ALGARUM UNICELLULARIUM GENERA *nova et minus cognita, præmissis* OBSERVATIONIBUS *de* ALGIS UNICELLULARIBUS *in genere.*

New and less known Genera of UNICELLULAR ALGÆ, *preceded by* OBSERVATIONS *respecting* UNICELLULAR ALGÆ *in general.* By ALEX. BRAUN. (Lipsiæ, 1855; with six Plates.)

Continued from No. XVIII, p. 96.

THE organs of fructification, and in particular the cells, by which the *Algæ* and cryptogamous plants in general are propagated, have received the most various names, for the most part insufficiently defined and applied in different senses.* Propagative cells undoubtedly occur widely differing among themselves, and frequently differing, and this is a point of the greatest importance, in the same plant.† For some differ but little, others as widely as possible from the vegetative cells; some are endogenous in their origin (in a simple parent-cell, or in two conjugated cells), some acrogenous;‡ they may be enclosed in a membrane either soft or rigid, simple or multiple; they may be inert or active (furnished with motile cilia); some are subservient to fecundation either in a direct § or indirect ‖ manner, some to germination, others altogether sterile.¶ Among those which

* The following terms have chiefly been employed: *spora, sporidium, sporidiolum, spermatium, speirema, sphærospora, zoospora, gonidium, gemmidium, conidium, gongylus, spermatozoidium, antherozoidium,* &c.

† Fructification of the double kind is extremely common; of the triple kind instances are afforded amongst the *Algæ*, in most of the *Florideæ*, in *Œdogonium, Vaucheria, Saprolegnia,* and *Chlamidococcus;* among the Lichens, in *Scutula* (Tulasne, 'Ann. d. Sc. Nat.,' 17, p. 118, t. 14); among the Fungi, in *Cenangium Frangulæ* (Tulasne, l. c., 20, p. 136, t. 16), *Bulgaria* (ib., p. 129, t. 15), *Dacrymyces* (ib., 19, p. 211, t. 13), *Erysiphe, Stemphylium* (De Bary, 'Verh. des pr. Gartenbauer,' 1853, p. 178, t. 2), *Peronostoma* (from the very recent observations of Caspery), &c.

‡ *Conidia,* stylospores, basidiospores, and *spermatia* of the Fungi and Lichens.

§ *Spermatozoidia* of the *Filicoideæ, Muscoideæ, Fucoideæ, Florideæ; spermatia* of Lichens and Fungi.

‖ Microspores of the *Lycopodiaceæ* and *Rhizocarpeæ.*

¶ Most *microgonidia* (*Chlamidococcus, Pediastrum, Stephanosphæra, Hydrodictyon, Cutleria*), the *pseudo-gonidia* (*spermatosphæria,* Itzigs.) of *Spirogyra,* &c.

germinate, some require fecundation, others germinate spontaneously, some at once, others after a long or shorter term of rest, some in totality, others after throwing off the perispore; most producing only a single individual, whilst some (under a divided germination) give rise to several individuals.* Propagative corpuscles (spores), moreover, also occur, either bicellular or multicellular. This being the case, a diversity of terms also becomes requisite, but what these should be, and upon what principle they should be framed, is at present not easy to determine, seeing that numerous considerations relative both to the origin and to the structure of the propagative cells, but more especially concerning their physiological import, fecundation, and germination, have not as yet been sufficiently inquired into. The terms, therefore, here set forth are proposed more for the temporary purpose of their being considered and judged of, than for use.

The author, in his work on 'Rejuvenescence in Plants,' p. 143, has endeavoured accurately to determine the difference between *spores* and *gonidia*, a difference which, at the present day, though difficult to sustain, it is neither incongruous nor useless to discuss. *Gonidia* are formed either in the vegetative cells themselves, or in cells only slightly differing from the vegetative character, filled with the same material, and for the most part resembling the vegetative cells in nature and colour; so that they represent, as it were, a cytoplasma liberated from the envelopes. Covered with a special delicate and soft integument, they proceed to germinate at once and in totality. From *gonidia*, which move by means of vibratile cilia, a transition to ciliated spermatozoids is afforded through the sterile microgonidia.† *Spores*, on the other hand, originate within cells more widely differing from the common vegetative cell, and are themselves distinguished by the altered nature of the contents and their peculiar colour. Furnished with special coats, double or multiple,

* The multicellular spores of most Lichens and Ascomycetes, many Gymnomycetes, and also of some Hymenomycetes (Tulasne, 'Ann. d. Sc. Nat.,' III, 9, p. 215, t. 13, *Dacrymyces*), represent in all respects compound spores, protruding in like manner from every cell, germinal filaments. The multicellular spores of *Pellia* ('Hofmeister vergl. Unters.,' p. 10, t. 4; Gröaland, in 'Ann. des Sc. Nat.,' IV, p. 13, t. 2), are of a different nature, representing a single germinal plantule, formed by a premature division of the primordial cell.

† Whether the gonidia of Lichens are altogether analogous with those of *Algæ* is not quite clear. Endogenous, as it would seem, in their origin, they agree with the gonidia of *Algæ*, but remaining within the texture of the *thallus* they are changed into free vegetative cells, which produce new and repeated series of *gonidia*.

they constitute, as it were, tunicated *gonidia;* in their germination, rupturing and throwing off the envelope (exosporium). Quite inert and dormant, as it were, they retain their vitality until the proper period for their germination arrives. But that the male function is also not incongruous with the form of a spore is shown in the pollen of phanerogamous plants, which is directly subservient to fecundation; and in the microspores of the Lycopodiaceæ and Rhizocarpeæ, from which fecundating spermatozoidia are produced.

Spores and *gonidia,* thus defined, agree in this, that they arise from an endogenous and a free formation of cells.* The acrogenous propagative cells constitute a series differing from both, which, formed at the summit of the supporting cell,† and at length proceeding to form an articulated series of cells, might be generally termed *conidia.* These occur very rarely in the class of Algæ,‡ but are extremely common and of varied construction in the Lichens and Fungi; some being very closely allied to vegetative cells (*conidia,* from the *mycelium* of Fungi), some assuming the nature of spores, whilst others, again, are analogous, in a certain sense, to spermatozoids; that is, they do not germinate, and the author is not aware that they are subservient to fecundation (*spermatia*) of Lichens and Fungi.

The author proposes the following conspectus of these organs, based upon the foregoing considerations:

A. A series of GONIDIA (*macrogonidia* and *microgonidia,* according to their size in the same species); *protogonidia, deuterogonidia, telogonidia,* if transitional generations of gonidia exist:

a. Gonidia immotile, in their nature very closely approximating vegetative cells (all germinating without fecundation): PHYTOGONIDIA:

* In the ultimate generation of cells, naked: *Glæocapsa, Oscillaria, Scytonema, Mastichonema, Zooglæa* (the gonidia of *Zooglæa,* though tremulous, have no vibratile cilia);

** Formed by the division of the contents of a single cell: *Scenedesmus, Cœlastrum;*

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* By a free cytogenesis, though in the widest sense of the term, the sense in which it is very recently defined by Pringsheim in his observations on the structure and origin of the plant-cell, who comprehends under the term "free cytogenesis," every formation of cells arising without inflexion of the cytoderm and from the contents alone. (Pringsh., 'Unters. üb. d. Bau u. die Bildung der Pflanzenzelle,' 1854, p. 62.)

† In what way these are formed, whether by a process of division, or by the coalescing of a free cell with the parent utricle, demands further inquiry.

‡ In *Batrachospermum* and *Lemanea.*

*** Formed by the union of the contents of two conjugated cells: *Diatomaceæ;*

**** Produced within special organs: "gemmidia" in "cystocarps," as in the *Floridiæ* (?).

b. Gonidia motile by means of vibratile cilia, otherwise differing but little from the common shape of cells (oblong and rounded), ZOOGONIDIA (vulgo "zoospores"):

a. Germinating (without fecundation), producing normal individuals:

* Solitary: *macrogonidia* of *Vaucheria, Œdogonium, Bulbochætes, Cutleria; gonidia* of *Coleochætes, Chætophora,* &c.;

** Numerous, arising from successive generations in the same cell (telogonidia): *Characium, Ulothrix;* macrogonidia and (?) microgonidia of *Ulva;*

*** Arising in the same cell, in a group by the simultaneous division of the cytoplasm (protoplasm): *Codium, Codiolum, Bryopsis, Hydrocytium, Chætomorpha, Cladophora, Laminaria; macrogonidia* of *Hydrodictyon.*

β. Germinating, but producing only depauperate individuals, which soon perish (pauperculæ): microgonidia of *Œdogonium, Bulbochætes;*

γ. Sterile, neither germinating nor fecundating: microgonidia of *Hydrodictyon, Pediastrum, Stephanosphæra, Chlamidococcus, Cutleria;*

δ. Fecundating (*spermatogonidia*):*

* Produced in numbers in the same cell: *Fucoideæ;*

** One in each cell: *Florideæ.*†

c. Gonidia motile by means of cilia, further removed from the nature of cells, filiform and twisted in spiral forms (*spermatozoidia*):

One formed in each cell: *Characeæ, Muscoideæ, Filices, Equisetaceæ, Lycopodiaceæ, Rhizocarpeæ.*

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* The spermatozoids, as they are termed, of the *Fucoideæ*, although, since the experiments of Thuret and Pringsheim, no doubt can be entertained as to their function, are widely different, with respect to their form, from the spermatozoids of the higher Cryptogams, and agree in all points with the germinating gonidia of the *Eclocarpeæ, Myrionemeæ, Laminarieæ,* &c. Agardh (Spec. gen. et ord. Alg. I, p. 9) terms the Zoogonidia in general and the spermatogonidia of the *Fucoideæ* in particular "Sporidia," speaking of them in the following words: "The sporidia of the *Fucoideæ* are without doubt analogous, on the one hand, with the sporidia of the *Zoospermeæ*, and on the other with the spermatozoa of the *Musci, Hepaticæ,* and *Characeæ.* It is of little moment whether their functions be the same or different. That the most various functions may be assigned to analogous organs is shown by very numerous examples. The pollen and spores are the same organs, but differing in function."

† That the spermatogonidia of the *Florideæ* move by means of cilia, has been noticed in several genera by Derbés and Solier ('Mém. sur la Physiologie des Algaes').

B. A series of SPORES (macrospores and microspores, if differing in size in the same species; hypnospores, if dormant for a long time):

a. True *germinating* spores (some without fecundation):

α. Simple, developed into a single germinal plantlet:

* Produced singly in each naked cell: *Œdogonium, Bulbochæte, Ulothrix* (*Hormotrichum*), *Vaucheria;*

** Gregarious in each naked cell: *Saprolegnia, Sphæroplea;*

*** Solitary in a pair of conjugated cells: *Desmidiaceæ, Zygnemaceæ;*

**** Serial, in cells (*asci*) of a compound organ (*apothecium, perithecium;* the simple spores of some *Lichens* and *Ascomycetes*);

***** Quaternary in the primary maternal cells (singly in the secondary) within compound organs: *Florideæ* ("sphærospores" without fecundation?), *Musci, Hepaticæ, Filices, Equisetum,* &c. (fecundation 0).

β. Compound (multicellular),* throwing out several germs,—PHRAGMATOSPORES, POLYPLASTIC SPORES:

Serial in the cells (*asci*) of a compound organ (*apothecium, perithecium;* most *Lichens* and *Ascomycetes*).

γ. Sectile, breaking up within the perispore into several gonidia, each of which germinates:

* Undergoing fecundation: *Fucoideæ;*

** Without fecundation: *Closterium* (?), *Euastrum* (?), *Rivularia* (?).

b. Subservient to fecundation—ANDROSPORES:

α. Directly fecundating:

Pollen of phanerogamous plants.

γ. Indirectly fecundating, producing spermatozoidia in their interior: microspores of *Selaginella, Isoëtes,* and the *Rhizocarpeæ.*

C. A series of CONIDIA:

a. Conidia in the more restricted sense of the term, arising from a *thallus* (*mycelium*) differing very little from vegetative cells, for the most part smooth-skinned (leptodermatous), germinating at once and in totality:

To this category appear to belong the spores of *Batrachospermum* and *Lemania;*† and obviously those of the Hyphomycetes, as well as of the Pyrenomycetes (*Erysiphe*) and Hymenomycetes (*Dacrymyce*).

b. ACROSPORES of authors (*sporoconidia*), produced in special organs more distinct from the thallus; widely different from vegetative cells, for

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* The individual cells of compound spores have by some been termed "sporidia," terms analogous to "folium" and "foliolum;" Fries employs the term "sporidia" to designate the naked spores of the Hymenomycetes.

† The spores of *Lemania* arising from the separated joints of the internal filaments germinate together with the perispore itself. (*Vid.* Wartmann, Anat. und Entwickelungsgeschichte der Algengattung "*Lemania*" (1854), p. 12, t. 3, f. 5.

the most part pachydermatous, and germinating through pores or a rupture of the exospore:

The naked and acrogenous spores of most of the Coniomycetes and Hyphomycetes (often compound or multicellular); the basidiospores of the Gasteromycetes and Hymenomycetes (for the most part simple); the stylospores of the Ascomycetes (*Bulgaria, Cenangium, Dermatia,* &c.) and of the Lichens (*Scutula*).

c. SPERMATIA (*spermatoconidia, androconidia*), very slender, minute cells, often exhibiting a tremulous motion, sterile or fecundating:*

In the Lichens and Ascomycetes, and also in the Hyphomycetes, *e. g.*, in *Trichothecium;* and the Hymenomycetes, *e. g.*, in *Tremella* and *Dacrymyce.*

With respect to the parts, lastly, by which the propagative cells are produced, it is well known that, in the different orders of Cryptograms, parts widely differing in value are designated under the same name, or that parts essentially identical have received different appellations, so that a more accurate terminology is much required. Thus it is, in the first place, desirable to distinguish in the organs of fructification those which are directly such, and simple, *i. e.*, parent-cells, within which propagative cells are generated, and those which more remotely perform the function and are compound, —those within which parent-cells are formed and contained. The former the author would term—1, *sporocytia,*† when they contain spores; 2, *goniocytia,* if containing *gonidia;* 3, *spermatocytia,*‡ if containing spermatogonidia or spermatozoidia; and the latter, for the same reason—1, *sporangia* (*sporocarpia,* Schleiden), to which belong the sporangia of Ferns and Equisetaceæ, analogous to which are the loculaments, or *thecæ,* of the anthers in phanerogamous plants, and also the *sporangia* of two kinds of the Lycopodiaceæ ("antheridia" and "oophoridia," Spring), those of the *Musci* and *Hepaticæ,* and lastly the *apothecia,* or *cymatia,* and *perithecia* of the Lichens and Pyrenomycetes, as well as their *pycnides* (Tulasne), containing stylospores, and the *peridia* of the

* Tulasne has noticed the germination of the spermatia of *Claviceps purpurea* (*Sphacelia segetum*), of *Sphæria typhina,* and *S. Laburni;* and Hoffmann ('Bot. Zeit.,' 1854, p. 268) the incomplete germination of the spermatia in *Hagenia ciliaris, tubercularia,* and *Trichothecium roseum;* the boundary, therefore, between the spermatia and other kinds of conidia would seem to be but ill defined.

† Schleiden terms these organs "Sporangia," a term elsewhere frequently used to express compound sporiferous organs; in the *Algæ* they are called sometimes "sporocysts," sometimes "perispores" (as in the *Fucaceæ*); the sporocytia of Lichens, Pyrenomycetes and Discomycetes are known under the names of "asci" and "thecæ."

‡ "Antheridia" of the *Fucaceæ.*

Gasteromycetes; 2, *goniangia*, to which would appear to belong the cystocarps of the Florideæ and the conceptacles of the *propagula* (*Scyphi*) of the *Hepaticæ* (*Marchantia, Blasia*); and 3, *spermatangia*, including the spermogonia (Talasne) of the Lichens and Fungi, and the antheridia of Ferns, Equisetaceæ, Mosses, Hepaticæ, and Characeæ. The term *sporocorpium*, lastly, should be reserved for organs distinct from the vegetative parts in which the sporangia themselves are inclosed, and which occur in the family of the Rhizocarpeæ. These organs are commonly termed "receptacles," or "conceptacles," under which term, indeed, widely different sporangiophorous organs are included, *e. g.*, the peculiar leaves bearing sporangia externally in *Equisetum* (*sporophylla*, Schleiden, *sporidochia*, Liuk, *carpophora*, Bisch), to which may be added the fertile fronds of the Ophioglosseæ and of some Ferns; and besides these, the peltate inflorescence (to use such a term) of the *Marchantiæ*, as well as the altered parts of the *thallus*, containing associated sporangia, in the Fucaceæ (*carpomata*, Kütz), to which the *stromata* of the Pyrenomycetes are in some respects analogous.

These introductory observations are succeeded by the description of several new or less known genera, viz., *Codiolum*, *Hydrocytium*, *Characium*, *Sciadium*, *Ophiocytium*, *Hydrodictyon*, and *Pediastrum* (subdivided into four sub-genera), illustrated with numerous figures.

COHN *on* VOLVOX GLOBATOR.

IN a paper recently read before the Academy of Sciences in Paris, Professor Cohn states that his own observations on the Volvocineæ have convinced him that the members of that family must be regarded as belonging to the vegetable kingdom, and that the *Volvox globator*, in particular, is properly placed among the Algæ. In this singular plant, as well as in *Eudorina*, *Gonium*, *Stephanosphæra*, and other Volvocineæ, each spherule is, properly speaking, not so much an individual as an association or family of individuals,—a sort of vegetable polypary. The globe of *Volvox* is formed at its periphery of an infinitude of very minute hexagonal cells, attached to each other in the same way as are the elements of an epidermic tissue. Each of the cells is furnished with

two motile cilia, and may be compared with a *Chlamydococcus*. The green endochrome is suspended, as it were, in the cavity, being connected with the wall only by means of filiform processes.

Like all the Algæ, the *Volvocineæ* present two distinct modes of reproduction; but up to the present time naturalists have been acquainted with only one of these, consisting in the repeated segmentation of the constituent cells, and resembling the fissiparity of *Chlamydococcus* and *Gonium*, or that of most of the Palmellaceæ.

The second mode of reproduction of *Volvox* requires a sexual conjunction, and is not observed indifferently in all individuals. The spherules, endowed with the sexual function, are distinguished by their volume and the more considerable number of their component utricles; they are generally monæcious, that is to say, they enclose at the same time male and female cells, although the majority of their contents are neuter. The female cells soon exceed their neighbours in size, assume a deeper green colour, and become elongated like a matrass towards the centre of the *Volvox*. The endochrome of these cells does not undergo fission. In other cells, on the contrary, which acquire the size and form of the female cells, the green plasma may be seen to divide symmetrically into an infinity of very minute particles, or linear corpuscles associated into discoid bundles. These are furnished with vibratile cilia, and oscillate, at first slowly, in their prism, but the movement soon becomes more active, and the bundles speedily break up into their constituent elements. The free corpuscles are very agile, and it is impossible to regard them as anything but true spermatozoids; they are linear and thickened at the posterior extremity; two long cilia are placed behind their middle, and the rostrum, which is curved like the neck of a swan, possesses sufficient contractility to execute the most varied movements. These spermatozoids, so soon as they are able to disperse themselves in the cavity of the *Volvox*, quickly crowd around the female cells, into which they eventually penetrate; arrived there, they attach themselves by the beak to the plastic globule, destined in each cell to form a *spore*, and with which they are gradually incorporated. Fecundation having been thus effected, the reproductive globule becomes enveloped successively by an integument exhibiting conical pointed eminences, and by an interior smooth membrane; the chlorophyll which it contained is now replaced by starch grains, and a red or orange-coloured oil. This is the condition of the spore at maturity, and occasionally forty of these bodies may be counted in a

single globe of *Volvox*. The germination of these reproductive bodies has not yet been observed, so that their history cannot be regarded as complete; but from analogy it may, in the meanwhile, be assumed that they germinate in the same way as do the spores of *Ædogonium*, *Sphæroplea*, and other Algæ belonging to the same order. It may be maintained, moreover, as certain that the *Sphærosira volvox*, Ehr., is nothing else than a monœcious *Volvox globator*; that his *Volvox stellatus* is also *V. globator*, observed at the time when it is filled with stellate spores; and, lastly, that the *V. aureus* of the same author differs from the other forms of the same species, simply in the smooth [and coloured] condition of the spores.

[*Note.*—With respect to the relations of *Volvox aureus* and *V. stellatus* to each other and to *V. globator*, observations precisely in accordance with those of Professor Cohn are contained in a paper by Mr. Busk, in the first volume of this Journal; and the description there given of the formation of the hypnospore, in the variety termed *V. aureus*, corresponds, in all respects, excepting the introduction of spermatozoids, with that above afforded. In the same place it is also hinted that this orange-coloured spore of *V. aureus* represents the "still-" or hypno-spore of other Algæ. It is also suggested, in the same paper, that *Sphærosira volvox*, Ehr., "may eventually be found to represent a peculiar mode of development of the same species." It is also noticed that the ultimate result of the segmentation of the zoospores in *Sphærosira* consists in the formation of numerous minute ciliated cells or corpuscles, forming by their aggregation a discoid body, in which the separate fusiform cells are connected together at one end. The important discovery (if confirmed by future observation) by Cohn that these fusiform bodies represent the spermatozoids of other Algæ, constitutes the important point in the paper of which the above abstract is given.—Eds.]

On a Peculiar Structure *in the* Columnar Epithelial Cells *of the* Intestines, *in connection with the* Absorption *of* Fatty Matters. By A. Kölliker.

(From the 'Verhandl. d. phys. med. Gesellschaft,' vol. vi, 1855.)

1. The epithelial cells of the small intestine in mammals, birds, and amphibia have on the side turned towards the cavity of the intestine a thickened wall, in which, under favorable circumstances, and with a good microscope, a manifest delicate striation may be perceived; which also, though with far more difficulty, and with certainty almost exclusively in the rabbit, when viewed from above, appears as a fine punctation.

2. This thickened, striated cell-wall, which may be readily perceived even in isolated cells, swells up in water and dilute solutions to more than double its primitive thickness, becomes very manifestly striated, even breaking up, as it were, into separate fibrillæ, so that the cells assume the aspect of ciliated cells. Ultimately water destroys the entire border from without to within, the innermost portion offering the longest resistance. Besides this, water induces two especial changes in the intestinal cells. In the first place, it forces mucous drops out of the uninjured cells, which have been erroneously explained as being swollen cells; and secondly, also, it frequently raises off the thickened membrane *in toto;* both of which circumstances are generally very readily distinguishable from each other.

3. In herbivorous mammals, the thickened and striated membranes are absent in the large intestine, as well as in the amphibia and birds; whilst in the carnivora and in man a faint indication of its presence may be discerned in this portion of the intestinal canal as well; in the stomach the membranes of the columnar cells do not present this characteristic.

4. In the mammalia, the fat before its absorption is transformed into immeasurably minute molecules, in which form it also enters the epithelial cells. The larger oil-drops, which, under certain conditions, are seen within perfectly recent cells, do not necessarily show that the fatty matter had entered in that form.

5. Among the common epithelial cells, there are found in all animals, and in every part of the intestine, other granular cells, of a more clavate form, mostly without distinct nucleus,

and which must be regarded as cells in a state of regeneration, ruptured at the upper end.

To these facts Kölliker subjoins the following *possibilities* and *suppositions*, which he recommends as subjects for further research:

1. The striæ in the thickened cell-membrane are pore-canals.*

2. Should this supposition prove correct, it would seem, in the first place, proper to place these canaliculi in direct relation to the absorption of fat; though, at the same time, it is also conceivable that they possess a more general significance, and that they stand in a general relation to the reception and secretion of material through cells. The former view is supported by the circumstance—

1. That in many animals (herbivorous mammals, amphibia, birds, &c.) the striated, thickened cell-membranes exist only on the surface of the small intestine, whilst they are wanting in its glands, as well as in the large intestine and stomach.

2. The columnar and ciliated epithelium of other localities presents no indication of the existence of a structure resembling pore-canals.

3. That the fatty matters are absorbed in the form of molecules, so minute, as, at any rate, to be capable of penetrating through the canals in question.

* In a note, Kölliker remarks that his supposed pore-canals have nothing in common with the imaginary pores stated by Keber to exist, not only in epithelial cells, but in all other bodies. (*Vide* 'Quart. Journ. Micros. Soc.,' vol. iii, p. 152.)

REVIEWS.

EMPUSA MUSCÆ, *and the disease of the Common House-fly. A contribution towards the knowledge of Epidemics characterised by the presence of parasitic Fungi.* By Dr. F. COHN. Breslau, 1855 (pp. 59, with three plates).

THE subject of this paper is the well-known, curious disease which prevails among common house-flies, at the period when the departing warmth of autumn induces them to seek shelter within doors.

At this time innumerable dead bodies of flies may be seen adhering to the windows, walls, shutters, &c., in all parts of the room. The dead insect, though dry and so friable as to crumble into dust upon the slightest touch, retains so far the attitude of life that it is difficult, without touching, to believe that it is not a living fly on the point of taking flight. Insects in dying usually draw up the legs and cross them beneath the body, but in the case of the disease now under consideration the dead body is supported upon the outstretched legs, whose feet retain their adhesive property, and by the protruded proboscis, with which the fly would seem to be sucking, and by which, even when the feet may happen to be detached, the body is still retained *in situ*. The dead flies in this condition are always surrounded with a halo, about an inch in diameter, composed of a whitish dust, which, upon examination, is found to consist of the spores of a *fungus*. The abdomen is much distended, and the rings composing it are separated from each other, the intervals being occupied by white prominent zones, constituted of a fungoid growth proceeding from the interior of the body. Further examination will show that the whole of the contents of the body of the fly have been consumed by the parasitic growth, and that nothing remains but an empty shell lined with a thin, felt-like layer, composed of the interlaced mycelia of the innumerable fungi.

This disease appears to have been long noticed, though, of course, in the absence of sufficient microscopic assistance, its true nature was not at first known.

First noticed, as it would seem, by De Geer in 1782, it did not escape the acute eye of the illustrious Goethe, who gives an accurate description of the phenomena attending it, and especially of the appearance of the white dust between the rings of the body, and its dispersion in a wide area around the dead insect. Accurate microscopic observations upon it

were made by Nees v. Esenbeck in 1827, though he did not arrive at any very definite conclusion as to the nature of what he observed. But, in 1835, M. Duméril declared the fine white dust to be a *true mould*, which had probably caused the death of the animal, in the same way that plants are killed by different species of *Erysiphe*. He compares it to the "muscardine" of the silk-worm.

In 1841, Mr. Berkeley determined the mould observed by Duméril to be the *Sporendonema muscæ*, Fries., with the following characters: "S. floccis simplicibus in cæspitulos sublobatos albos conglutinatis" ('Systema mycologicum,' 1829, iii, p. 434); the fertile filaments (flocci) are said to be filled internally with serially disposed, spherical sporidia.

Cohn, though admitting that the last-mentioned circumstance may be explained by the action of water upon the contents of the filament, thinks it necessary, in giving a new diagnosis, also to dignify the fungus with a new name, and to erect it into a new genus under that of *Empusa*, with the following characters: "*Empusa*, entophyta, e tribus constans cellulis, quarrum infima in insecti cujusdam alvo evoluta, mycelii instar tortuosa et ramificata superne prolongatur in mediam, extrorsum tandem erumpentem, stipitis vel basidii instar spora simplici, elastice demum protrusa coronatum."

Em. muscæ, n. sp.: Cellula myceliiformi $\frac{1}{200}'''$ lata, sursum in claviformem $\frac{1}{100}'''$ latam excurrente, spora campanuliformi $= \frac{1}{100}'''$.

The author gives a long, interesting, and very particular account of his observations upon this parasitic growth, and finally sums up his conclusions in the following propositions, which include all the main points in the paper.

In a postscript noticing M. Tulasne's observations on the development of the Uredineæ,* he himself, however, admits that they are calculated to throw very strong suspicions upon the correctness of one of the main propositions which it seems to have been the object of this memoir to establish, viz., "that in the fluid which fills the abdominal cavity of the diseased fly numerous cells arise by free cell-formation, which cells, by gradual development, are formed into the tricellular *Empusa*." A sort of equivocal generation, the establishment of which in any case will indeed require very much stronger evidence than has yet been afforded, and especially in the instance of growths like the present, of whose modes of development much still remains to be made out.

* 'Mémoire sur les Urédinées et les Ustilaginées.' (Ann. d. S. nat., 4 sér., t. ii, 1854, pp. 77—193.)

1. In the autumn the common house-fly is subject to a fatal disease, which occurs epidemically, and disappears in the course of the following winter.

2. This disease is characterised by the development of a microscopic *fungus—Empusa muscæ*—in the interior of the body of the fly; the death of the insect is caused by the vegetation of this parasitic growth.

3. The disease is manifested externally, at first by a degree of slowness in the motions of the flies; at this stage, the fluid (blood) which occupies the interspaces between the viscera increases greatly in amount, and is found to contain innumerable fat-drops, which give it a milky appearance.

4. Innumerable very minute free cells make their appearance in the blood, having a very delicate, at first indistinguishable membrane, and granular contents.

5. These cells rapidly attain to a very considerable size, and when uniformly nourished retain their original spherical or ovoid form; but usually, owing to the unequal supply of nutriment, probably referable to the circulation of the blood, they assume the form of longer or shorter tubes.

6. The globular or tubular forms exhibit towards water and other reagents, precisely the same reaction as do cells originating in free cell-development. When placed in water they swell out considerably, and even the most elongated tubes soon acquire a globular figure, their contents at the same time coagulating and exhibiting large oil-drops; the membrane, in the younger stages, is dissolved altogether in the water; older cells merely burst at one end, through which the contents escape.

7. A few hours before death the fly ceases to exhibit any spontaneous movement; the abdomen becomes much distended by the increased quantity of blood-fluid, and in consequence of the innumerable, free, occasionally very large fungus-cells floating in it.

8. At this time all the fungus-cells have regained the ovoid form, probably owing to the uniform nutrition which they receive when the circulation of the blood ceases; at one, more rarely at two points of these cells, cæcal processes are formed, which elongate in a root-like manner, interlace with each other, and throw out branches. Many thousands of them in this condition surround the viscera without penetrating into their substance; nevertheless, it is soon apparent that the parasitic fungi are nourished at the expense of the tissues.

9. After death, the body of the fly exhibits peculiar contortions and extensions of the legs, wings and abdomen;

the proboscis is protruded, and firmly adheres by suction to the wall, &c.; in consequence of their adhesion by this part, and by the outstretched legs, the dead insects remain attached to the surface, just as if they were still alive; their bodies dry completely, and become excessively friable.

10. The blood-fluid, as well as the viscera, are gradually consumed by the parasitic Empusa, whose radical extremity continues to elongate, whilst the opposite end expands into a clavate head. Owing to the development of the parasitic growth, the abdomen of the insect continues to enlarge more and more, and the rings of the abdomen to separate from each other.

11. Eight to ten hours after death the delicate membrane by which the segments are united, is perforated by the clavate extremities of the *Empusa*-cells, which then appear on the exterior, forming white zones, which continue to increase in width, between the rings of the abdomen.

12. The clavate exterior extremity of the fungus-cells grows rapidly, and by the formation of a dissepiment at the lower (internal part) becomes divided into two, so that the fungus now consists of two cells—a radical and a peduncular.

13. The peduncular cell is elongated at the apex into a short, cylindrical process, which soon expands into a vesicular form, is filled with the plasma which continues to flow into it, and separated from the lower portion by a transverse dissepiment. In this way is formed the unicellular *spore*, which soon assumes a bell-shaped form. The *Empusa*, consequently, is a typical, *tricellular* plant.

14. From the elastic pressure exerted by the peduncular cell, the spore is projected to the distance of about an inch. The scattered spores form a white dusty area around the dead flies, and adhere firmly to their wings and legs.

15. The spores are often found enclosed in vesicles, and thus become assembled into little masses; the origin of these vesicles has not yet been ascertained with certainty.

16. Success has not yet attended attempts to effect the germination of the spores, either in water or moist air, or by artificially affixing them upon or introducing them into the interior of living flies.

17. If a fly dead of this disease be placed in moist air, fungi are developed upon it, but belonging to forms which, manifestly, have no genetic connection whatever with *Empusa* (*Penicillium*).

18. At present, consequently, there is no evidence whatever to show the relation of the *Empusa*-spores to the appearance of this *fungus* and of the disease, whilst the

chemical and optical relations of the innumerable, free cells in the blood-fluid, the absence of any special, self-extending *mycelium*, and especially the entire history of the development, appear to favour the notion of the origination of the *Empusa*-cells in a free cell-development in the morbidly altered blood.

19. This disease of the fly, so far as at present known, finds its only analogue in the epidemic disease of the silk-worm termed "*Muscardine*," which has been ascribed to an entirely different *fungus—Botrytis Bassiana*.

20. But until the "Muscardine" shall have been subjected to renewed and thorough investigation, no accurate judgment can be arrived at with respect to the relation of the two diseases to each other, a few observations rendering it doubtful whether the *Botrytis Bassiana*, or, more probably, a fungus allied to the *Empusa muscæ*, may not play the principal part in this disease.

The above account of *Empusa muscæ*, the author observes, was in print before the appearance of M. Tuslasne's Mémoire sur les Urédinées et les Ustilaginées' ('Ann. d. Scien. Nat.,' 4 sér., tom. ii, pp. 77—193, 1854); in which paper an account is given of the development of numerous "smut-fungi," which differs from all that was previously known with respect to the development of these microscopic organisms, and which, moreover, would seem calculated to throw a new light upon the origin of certain morbid phenomena.

In the germination of this class of fungi, for instance, the peculiar, uni- or multi-cellular hypnospores, containing much oily matter, and having a double membrane, are not at once and directly developed into a new *mycelium*, but the *endosporium* breaks through the outer membrane (*cuticula*) of the spore and elongates into a short tube, which in length but slightly exceeds the spore; this germinal tube, *tube-germe, promycelium* (which would appear to correspond with the *prothallium* of Mosses or the *pro-embryo* of Ferns), then bears a considerable number of *secondary sporidia*,—in the "smut" of wheat (*Tilletia caries*) 8—10 in number,—of a long-fusiform, *fusidium*-like shape, united in pairs by a transverse band, and consequently altogether dissimilar to the peculiar, primary spore. These *sporidia* soon detach themselves from the germinal tube, whose entire protoplasm was employed in their formation. These secondary spores even do not usually appear directly to throw out a *mycelium*, but first become elongated into peduncles, supporting at the summit reniform cells—*tertiary sporidia*. At present it has not been observed

whether the tertiary *sporidia*, when they have reached a wheat-plant, are directly developed into the "smut-fungi" from which are produced the well-known (primary) *Tilletia*-spores, and thus close the entire cycle of a complicated alternation of generations. (These results of M. Tulasne's observations have been confirmed by H. Kuhn, of whose merits as an observer Cohn speaks highly, and also by himself).

These observations indicate, at any rate, that in the above class of parasitic fungi each spore does not immediately produce a new plant, but in the first place a considerable number of spores of another form and structure, from which only the true *mycelium* is developed. A very few spores, therefore, are sufficient to produce a vast number of *fungi*, and in this way to destroy whole ears of corn.

The author's conclusions respecting the development of the *Empusæ* in the fly were based principally upon the fact, that their origin could in no way be explained according to the views at present prevailing in science, since neither the true spores of the *fungus*, which are never met with there, could penetrate directly into the abdominal cavity of the diseased animal, nor could any *mycelium*, in any way originating, form spores which might have germinated upon the surface of the fly. Since, moreover, the youngest conditions of the *Empusæ*, which I have observed, he says, in the fly's blood, were far smaller than and of an entirely different structure to the characteristic spores, and were also from the first present in vast numbers, the only conclusion left to be drawn was that they had arisen in free cell-development. M. Tulasne's discoveries have now, however, at any rate, shown us the possibility of another mode of origin by means of the spores. It might be supposed that in the interior, or on the outer surface of a fly, a few, and therefore readily overlooked, *Empusa*-spores may have become developed, and at first, like the "smut-fungus," may throw out short germ-tubes, which afterwards, in some way, produce a great number of smaller, differently formed cellules (*sporidia*), which subsequently grow into complete *Empusæ*. In this way, at all events, may be explained the multitudinous appearance of free, minute *Empusa*-cells, without any necessity for the entrance of as many *Empusa*-spores, or of a spreading mycelium.

Although M. Tulasne's researches indicate the possibility of such a mode of development, also, in the genus *Empusa*, it must be allowed that it has not been proved that such a process really takes place. In opposition to such an assumption we have, he says, not only the want of all the supposed

intermediate stages, but, in particular, also are the anatomical, physical, and chemical conditions of the younger *Empusa*-forms, which appear in all respects to present the characters, not of spores, but of young, newly formed cells. Further researches are requisite to bring this question to a satisfactory determination.

A Synopsis of the British Diatomaceæ. By WILLIAM SMITH, F.L.S. London: Smith and Beck, and Van Voorst.

THOSE microscopists who are working at the British Diatomaceæ will rejoice to know that the second volume of Professor Smith's work is at last completed. They have now a complete work to which they may refer for information with regard to all forms of British Diatomaceæ. This second volume is a worthy companion of the first. The descriptions of the species are ample, the notes are valuable, and the plates, if possible, exceed the last in their beauty and accuracy. With regard to the latter, we are sure that Professor Smith would be amongst the first to acknowledge how greatly the value of his work is enhanced by the unrivalled skill with which Mr. Tuffen West has delineated the beautiful objects he has described.

Since the publication of the first volume in 1853, many new species belonging to genera there described have been discovered; and although Professor Smith has given a list of those in an appendix, with references to the works in which they are described, mostly in our own Journal, yet every one will be glad to hear that he intends publishing a Supplement. Many of the new species require criticism and revision, and a Supplement will afford Professor Smith an opportunity of not only hauling over the contributions of his friends, but some of his own.

The Introduction to the present volume contains some interesting remarks on the history of the Diatomaceæ. The first section takes up the question of reproduction. Little seems to be added as to the nature of this process, since the first observations of Mr. Thwaites. The fact of the production of the spore as the result of conjugation has, however, been observed up to the present time in no less than thirty-two species, belonging to seventeen genera. Of these, Professor Smith gives a list. On the modifications of this process, Professor Smith makes the following remarks:

"I. We have two parent-frustules, and two sporangia as

the result of their conjugation. This mode is seen in *Epithemia, Cocconema, Gomphonema, Encyonema,* and *Colletonema.*

"II. From the conjugation of two parent frustules we have a single sporangium. This occurs in *Himantidium.*

"III. The valves of a single frustule separate; the contents, set free, rapidly increase in bulk, and finally become condensed into a single sporangium. This may be seen in *Cocconeis, Cyclotella, Melosira, Orthosira,* and *Schizonema.*

In *Melosira nummuloides, M. Borrerii,* and *M. subflexilis,* the second valve of the conjugating frustule is rarely found united to the mucus surrounding the sporangium, the conjugation taking place only in the last frustule of the filament; but in *Melosira varians* and *Orthosira orichalcea,* conjugation taking place throughout the entire filament, both valves are usually found adherent to the sporangium or its surrounding mucus.

"IV. From a single frustule, as in the last method, two sporangia are produced in the process of conjugation. This takes place in *Achnanthes* and *Rhabdonema.*

"On the whole, the facts at present within our knowledge seem fully to warrant the conclusions that the conjugated state of the Diatomaceæ is the first step in the reproductive process of these organisms, and that the sporangial products of this condition become the parents of numerous young frustules, destined to renew the cycle of phenomena which accompanies the life and growth of the species from which the sporangia have themselves originated."

In the next section Professor Smith enters upon the question of the nature of the Diatomaceæ, and successfully, we think, vindicates their claims to be regarded as members of the vegetable kingdom. Although he does not refer to any experiments, he states that the Diatomaceæ give out oxygen from their tissues, and take up carbonic acid gas. If this has been proved by experiment, we should regard it as conclusive of their vegetable nature, as the performance of these functions seem to be the most universal condition of the existence of plants of which we have any knowledge.

In the concluding sections Mr. Smith treats of the determination of species, and of the distribution and uses of the Diatomaceæ. We can only repeat that this volume fully maintains the reputation of the first, and express our conviction that the whole work is one of the most important contributions ever made to microscopic natural history in this country.

Hints on the Pathology, Diagnosis, Prevention, and Treatment of Thoracic Consumption. By J. C. HALL, M.D. London: Longmans.

IN the ordinary course of noticing works interesting to those who use the microscope, we are not often called on to bring before our readers works devoted to the practical departments of medical science. At the same time, we are convinced that this does not arise from any deficiency in the microscope; but from the want of skill in the use of it amongst those who practise the medical profession. In an art so dependent on a correct appreciation of facts only known to exist by sight, it must be evident that the microscope will become essential to all conclusive investigations, and that scarcely any correct diagnosis will be made without its aid. We notice, therefore, Dr. Hall's book, because in the first place we think he has made good use of the microscope in the diagnosis of disease, and in the second place because he has been kind enough to put one of the plates, illustrating his work, at our disposal (Pl. X.) We shall not, however, criticise Dr. Hall's book, but let him speak for himself on the subject of the use of the microscope in the diagnosis of tubercle. He says:

"Since the publication of the former editions of this work the microscope has thrown no little light on the true nature of tubercle, which may, in almost every instance, be regarded as an exudation of proteine material rapidly passing into the solid form, and never advancing beyond the lowest grade of development. In examining tubercles from the lungs, it has ever appeared to me that considerable difficulty must be experienced in arriving at a correct histological definition; for no little risk is of necessity incurred of regarding half-destroyed tissues as new products, and hence one reason for the different opinions expressed by different writers on this subject. With regard to the seat of tubercle in the lungs, it may be stated that tuberculous matter is deposited primarily on the free surface of the lining membrane of the air-vesicles, the inter-vesicular passages, or the lobular bronchi. Dr. Clark, in his remarks made to the Pathological Society on the preparations illustrative of the seat of tubercle, shows that the deposit of tubercles takes place primarily on the free surface of the lining membrane of the air-vesicles, the inter-vesicular passages, or the lobular bronchi—that it extends to the walls of the air-vesicles, the areolar tissue around the blood-vessels and bronchi; and between the lobules only at an advanced period of growth, when such retrogressive changes have set in as involve destruction of the structural elements of the lung; and that it does not occur *indifferently* at any point external to the blood-vessels.

"There are two principal varieties of tubercle known as *gray tubercle* and *yellow tubercle*, of which the admirable delineations of Mr. Tuffen West in the plate convey to the eye a correct representation. The tuberculous matter for the most part assumes a spherical form, its origin being in a blastema exuded from the adjoining capillaries, which, effused in a fluid

condition, infiltrates the tissue. The elements of tubercle, according to Wedl, Vogel, Lebert, Gluge, Rokitansky, and as far as my own observations enable me to judge, may be described as—

"(*a*) Molecules, assembled in superimposed layers, some too minute to be measured.

"(*b*) Flocculent masses, consisting of proteine bodies, only seen when the tubercle is carefully spread out.

"(*c*) Rounded or oval nuclei, imbedded in a hyaline matrix, with scattered molecules.

"(*d*) Flattened angular, granular corpuscles, rarely with a distinct nucleus, which become transparent on the addition of acetic acid.

"(*e*) Cells, occasionally elongated, with distinct nuclei.

"*Gray tubercle* is of uniform consistence, toughish or soft, compressible, and of a pearly gray colour; it is composed essentially of 'a basis substance, which is solid and homogeneous, and serves as the uniting medium of certain corpuscular elements;' such as oily-looking granules, nuclei, and a few cells; the elements of the tissue in which it is deposited may also frequently be seen. I have never discovered any vessel in separate tubercles, although when several are aggregated together, in the interspaces some traces of those belonging to the tissue may be observed.

"*Yellow tubercle*, which usually forms in larger masses than the gray, varies in colour, though generally of a whitish-yellow hue. These tubercles are from the first opaque, of a cheesy consistence, containing a large abundance of fine proteine molecules, among which may be detected the elements of gray tubercle, shrivelled, indented, and wrinkled, and of a yellowish lustre. The relation of the two varieties of tubercle to each other is a point of considerable interest; and Laennec without doubt was right when he taught that gray tubercle sooner or later is converted into yellow tubercle. This undergoes two metamorphoses of very great importance to the practising physician; *one is that of softening—the other that of cretification.* That yellow tubercle should be thus regarded as a secondary form of gray tubercle is generally correct, and also in strict accordance with the fatty metamorphoses of normal and newly formed elements; but it has been suggested with some probability that the remains of the proteine compounds, which have not been used in the formation of the organic elementary parts, may at once undergo fatty degeneration; and, consequently, that it is not absolutely necessary that the yellow tubercle should have previously been of the gray kind."

Further on, Dr. Hall gives precise directions for examining the expectorated matter in cases of disease of the lungs:

"To form a correct opinion of the nature of the sputa submitted to us for examination requires no little time and study. It obliges a thorough knowledge of the appearances of the secretion natural to the mucous and salivary glands, the epithelium of the mouth, of the fauces, and the pharynx, and the results of the varied morbid processes which may take place in the several parts. Portions of fungous vegetations, which are so frequently present at the back of the mouth and in the matter secreted by the tonsils, are very often seen in the expectoration, mingled with the remains of the food that has been taken; such as muscular fibre, starch, oil globules, various vegetable and animal substances, &c. It must not, therefore, hastily be concluded that everything we see in the sputa, under the microscope,

comes from the air-tubes. And, again, in examining the expectoration in certain trades—such, for example, as the grinders of Sheffield—various small particles of stone and of steel may be readily detected. The appearances vary a good deal, however, in these men with the time of the day at which the expectoration has been coughed up, and whether or not they have been working within a short period at the wheel. Pus, blood-corpuscles, claws of Echinococci, and portions of hydatids, are sometimes present, and in the more advanced stages of pneumonia numerous large cells containing oil globules will be seen, together with many finely granular cells, not very unlike pus globules, but which, on the addition of acetic acid, do not exhibit the presence of central bodies. Sometimes the sputa contain small fragments of pulmonary tissue, frequently distinct and well defined, but which are easily overlooked without a good deal of care. The small white calcareous masses which are not unfrequently present in the sputa in cases of arrested thoracic consumption, and of which Mr. Tuffen West has given a good illustration in the plate, as well as of some crystals of cholesterine, are best examined by mounting them as opaque objects, on a black ground, and looking at them through an inch object-glass. Sometimes in the cheesy matter found so largely in tuberculous masses we may not be able to detect crystals of cholesterine; it is better then to place a little bit of the mass on a slide, and to add a small quantity of alcohol. As this evaporates, crystals of cholesterine gradually form, and may then be easily examined under the microscope. They are very beautifully seen by polarized light. If the calcareous masses to which reference has just been made be placed in a watch-glass, and tested with a little acetic acid, they will dissolve with effervescence, demonstrating the presence of a carbonate. If to one part of the acetic acid solution an excess of ammonia be added, a precipitate of phosphate of lime takes place, and a little of a solution of oxalate of ammonia added to the other portion will detect the presence of lime."

The following remarks apply to the character of the sputa in true cases of tubercle of the lungs. The appearances described in the following paragraphs are illustrated in Plate X of the present volume of the Journal.

"The first kind of expectoration observed in thoracic consumption is frothy, and is characteristic of irritation. So far as my own experience goes, it does not enable us to arrive at any correct conclusion as to the existence of tubercle when placed under the microscope; and many of the appearances may arise from other causes. After a longer or shorter period, as the disease may be impending or established, the expectoration becomes gelatinous, rather transparent, and resembles a solution of isinglass. This expectoration is generally brought up in a morning in the dressing-room, and scarcely noticed by the patient. It consists of a transparent and very tenacious semi-fibrillated matrix, in which we may see imbedded oily matter, molecules, granules, and corpuscles. This kind of expectoration may often be seen in various forms of pulmonary congestion. The investigations I have made in numerous cases of phthisis enable me to conclude with certainty that we have, in looking at this kind of expectoration, a diagnostic guide of very great practical importance; for where there is no special tuberculous tendency the corpuscles are of one uniform kind, but when the deposit of tubercle has taken place or is impending the corpuscles are of various forms and sizes. Some are ovoidal, some spherical, and resist the action of acetic acid; others are abruptly defined, obscurely granular or nebulous, requiring the application of reagents to render their

nuclei apparent. Others, again, are compressed and elongated; another set may be seen of a spherical form, which are filled with granules of fat or pigment, and these are often in process of disintegration; and, lastly, corpuscles may be seen with depressions, from which nuclei have been extruded. The first kind of corpuscles, Dr. A. Clark considers to consist of very young epithelial cells and extruded nuclei; the other varieties are unquestionably diseased epithelial cells, in various stages of degeneration. The jagged outlines of the corpuscles (to which allusion is made in the case described pp. 46 and 47), is a point of great interest to the practitioner, and almost certainly diagnostic of phthisis. Dr. C. Radclyffe Hall has drawn attention to the appearance in the sputa, of *enveloped blood-corpuscles*, at the commencement of thoracic consumption. In a great majority of the cases in which I have examined the sputa this microscopic hæmoptysis has been evident, even when to the naked eye there was no trace of blood, and the opinion of this physician, that this appearance is seldom absent in cases of the disease in which the more obvious expectoration of blood is wanting, is strictly in accordance with what I have observed.

"The next kind of expectoration is met with at a more advanced stage of thoracic consumption. A highly characteristic example is given (pl. i, fig. 6) of this flocculent sputa, in which will be seen a large piece of the curled elastic tissue surrounding the pulmonary vesicles. The expectoration was obtained from Sarah Ann Chambers, aged 18, admitted during the month of October, 1856, under my care, at the Sheffield Public Dispensary, with signs of softening at the apex of one lung. It is at the period of the formation of these excavations in the lung that I most frequently observe the elastic tissue forming the areolæ of the air-vesicles, partially obscured by masses of molecular matter in which tubercle-corpuscles may be seen, and it then becomes an important aid to the formation of a correct diagnosis. I may observe that the elastic tissue shown in the plate is exactly a quarter of the actual size of one of the pieces in the preparation put up by me, from which Mr. Tuffen West's drawing was made. The pus globules, shrivelled cells, disintegrated nucleated cells, &c., &c., found in the sputa of this patient, will be described at the end. I have never yet met with a case in which I discovered, with the microscope, the elastic tissue of the lungs in the absence of all other symptoms indicative of thoracic consumption. Such a case, however, has occurred, in which that accomplished physician, Dr. Bennett, after a careful examination with the stethoscope, could not detect any physical sign of consumption. The case was seen with W. T. Iliff, jun., Esq., of Kennington. Professor Bennett says, 'the chest was well formed; careful percussion and auscultation elicited positively nothing; the percussion note was normal and equal on both sides; the respiratory murmurs were normal, and there was no increase of vocal resonance.' There was cough and muco-purulent expectoration. This patient, a lady, aged 23, had an impression she was in the habit of spitting up fragments of her lungs. Some of them were examined by Dr. Bennett, Mr. Quekett, Mr. Rainy, and Dr. Beale, all of whom agreed as to the fact of the expectorated matter containing portions of human lung. After a time the physical signs of the disease became more clear, and on examination after death extensive tuberculous disease of both lungs, with cavities in their apices, was found. This case has fully impressed Professor Bennett with the importance of a microscopic examination of the sputa whenever the symptoms and a suspicion of thoracic consumption exist, without any clear evidence derivable from auscultation being present; and when such signs are present as lead to the conclusion that a cavity is just forming, microscopic appearances of the sputa, such as are shown on the sixth figure of the

first plate, afford, I am certain, no little evidence confirmatory of our opinion.

"At a more advanced period of the disease, when there is a large cavity, the sputa is little more than pus, mucus, large granulous cells, and sometimes portions of opaque tubercle, and confervoid vegetations."

Dr. Hall's volume is small, and is written in a manner which gives it a claim to be read by all who are interested in the study of tubercular disease of the lungs.

Ueber die Entwickelung und den Bau des Säugethierzahns. Von Dr. Adolph Hannover.

('Verhandlungen der Kaiserl, Leopold-Carolinschen Akademie,' vol. xxv, p. ii.)

In this beautifully illustrated memoir, Dr. Hannover contributes much interesting information with regard to the histology of the dental tissues in the *Mammalia* generally; but we suspect that both by the author, and by the scientific public, the pith of the essay will be considered to lie in the views respecting the development of the teeth, whose exposition occupies so large a portion of it. It is to these, therefore, that we shall chiefly direct the reader's attention in the course of the following critical analysis. Dr. Hannover commences his work thus:

"The dental sac of *Mammalia* contains four elements, which, without coalescing, lie in contact, and are distinguishable by their very peculiar structure. Below, on the bottom of the sac and coalesced (verwachsen) with it, lies a soft body, which at a very early period acquires the form of the crown of the tooth. This body is the dentine-germ (dentin-keim); by a process which we shall call 'dentification' it becomes dentine, a substance characterised by the branched tubules which it contains. The dentine-germ is immediately covered by the enamel-germ: this consists of cells (the enamel-cells), on the whole arranged perpendicularly, which are at first very soft, but subsequently, by calcification, become solid columns, and constitute the hardest substance of the tooth—the enamel. Most externally in the dental sac lies the cement-germ, which, by a process of ossification quite analogous to that which takes place in bone, is changed into cement, characterised by its osteal lacunæ and medullary canals. The cement-germ, however, lies in immediate contact neither with the enamel nor with the dentine, but is separated from them by a peculiar membrane, not yet sufficiently distinguished; this carries upon its inner surface the enamel-cells, which are disposed perpendicularly upon the dentine, and consequently it separates the cement-germ from the enamel-germ; but where the enamel-germ ceases it separates the cement-germ from the dentine-germ. We shall term this membrane the *membrana intermedia;* in the complete tooth it appears as the *stratum intermedium.*" (p. 3.)

The careful study and collation of different passages in Dr. Hannover's work show that his dentine-germ is the dental papilla of English writers; that the enamel-germ is the *membrana adamantinæ;* that his *membrana intermedia* is the layer of what Nasmyth ('Researches on the Development, &c., of the Teeth,' 1849, p. 107) describes as "oval cells," seated on the deep surface of the stellate tissue of the enamel-organ; and that his cement-germ is nothing more than the stellate tissue of the enamel-organ, which he confounds with the vascular "actinenchyma" or peculiar connective tissue of the proper wall of the dental sac.

Under the head of the development of the enamel, Dr. Hannover offers us nothing new; but repeats, without bringing forward new evidence, and as if it had never been disputed, the old view that the enamel is produced by the direct calcification of the columnar cells of the *membrana adamantinæ.* Nor can we find any essential difference between Dr. Hannover's theory of the formation of the dentine and that advocated by Professor Kölliker and others, except that he denies the existence of a *membrana preformativa,* and affirms that—

"This so-called membrane is, in my opinion, nothing but the outermost layer of dentine-cells, in which dentification has just commenced." (p. 12.)

How this can be reconciled with the unquestionable facts that the *membrana preformativa* can be traced with great ease, uncalcified, on to the primary cap of dentine, and that it is a structureless membrane in which no trace of cells has ever yet been detected, we know not; but we are inclined to suspect that Dr. Hannover has never seen the true *membrana preformativa.*

As regards the *membrana intermedia* we are desirous to do Dr. Hannover no injustice in endeavouring to explain, what seems to us to be, his erroneous view of its functions and homologies in the adult tooth, and we will therefore cite his account of it at length.

"4. *Membrana intermedia.*

"I have bestowed this name upon a membrane which has not as yet received sufficient attention.* It is a fine and delicate membrane, which must not be confounded with the membranous expansion of the enamel-

* Kölliker has, perhaps, figured it in his 'Mikroskopische Anatomie,' p. 99, fig. 211 *d*, without, however, recognising its true nature. What Tomes has termed "basement membrane" appears to have been not exclusively the *membrana intermedia.*

cells, and which lies within the cement-germ, between it and the enamel-cells. It appears in transverse sections of the germ as a fine white line; is a tolerably firm and opaque membrane, and consists of a structureless mass, in which very numerous small, round or oval, angular or pointed nuclei, without distinct nucleoli, are imbedded. The boundary towards the cement-germ is sharp and linear, and the cells of the cement-germ are pressed against it (fig. 11 *a*). The boundary towards the enamel-cells, which lie upon the opposite surface, is also well defined (fig. 19 *a*). The enamel-cells may be detached with tolerable ease, whilst it is only with difficulty that the *membrana intermedia* can be separated from the cement-germ. It is, therefore, best examined in connection with the cement-germ, and, indeed, in the teeth of the new-born infant. In order to observe the attached enamel-cells, the membrane may be folded, because in thin sections the enamel-cells easily fall off.

"The thickness of the *membrana intermedia* differs considerably in dental sacs of different ages. In the persistent teeth of the new-born infant it is hardly visible to the naked eye; in their milk-teeth it is very easily recognisable, in consequence of its white colour, and has considerably increased in thickness; it is thickest, perhaps, about the constricted part or neck of the dentinal germ, with which it is also more intimately connected. Fig. 19 *a* shows its thickness in the deciduous molar of a new-born infant.

"The *membrana intermedia* does not belong to the crown or the enamel alone, for it is continued uninterruptedly upon the fang, here separating the dentine from the cement, and, as in the crown, lying upon the inner surface of the cement-germ. However, I have not been able to demonstrate it here in an isolated form, because, immediately on the formation of the outermost layer of dentine, it coalesces with it, and can be recognised only from its appearance in the complete tooth, where we shall find it as the *stratum intermedium*. If we consider the *membrana intermedia* as a whole, it may be regarded as a sac-like structure which is inclosed within the dental sac, so that the cement-germ is situated between the *membrana intermedia* and the dental sac; perhaps the membrane becomes reflected over the inner surface of the dental sac."

Now there can be no doubt as to the existence of this layer. It was, as we have seen, described by Nasmyth; it is, as Dr. Hannover justly states, figured by Professor Kölliker; and we have repeatedly seen it ourselves without feeling inclined to lay any very particular stress upon its existence. If there is any advantage in calling it *membrana intermedia*, we shall be happy to adopt this term. But we must demur to Dr. Hannover's view of its ultimate fate, as contained in the following passage (p. 110) of his memoir.

"4. *Stratum intermedium.*—The nucleated membrane, which during the development of the tooth is closely united with the cement-germ, and serves for the attachment of the nucleated end of the enamel-cells, and to which we have given the name of *membrana intermedia*, is always sufficiently obvious in the perfect tooth, though much changed. It receives its persistent form only after the enamel-cells are calcified throughout their whole length; since it lies between the enamel-cells and the cement, the ossification of the cartilaginous cement-germ can only take place after the completion of the development of the *membrana intermedia*. Hence in the crown it always separates the enamel, in the root, the dentine, from the cement. Since,

however, the cement-germ as a rule does not ossify, but becomes abortive on the crowns of teeth with conical dentine-germs, the *membrana intermedia* in such crown lies free, and in teeth which have not been worn forms what Kölliker terms the cuticle of the enamel."

Dr. Hannover then goes on to speak of the identity of his *stratum intermedium* with the "persistent capsule" of Nasmyth; and he describes the mode of raising up the membranous *stratum intermedium* in young teeth, by the action of dilute acids, which he states to have been discovered by Erdl in 1843.

Dr. Hannover appears to be unaware that this persistent capsule, or "Nasmyth's membrane," has of late been the subject of special investigation on the part of Professor Huxley, M. Lent, and Mr. Tomes, and therefore he does not attempt to meet the obvious objections which an acquaintance with the known relations of Nasmyth's membrane in the young dental sac would have suggested. Inasmuch, in fact, as Prof. Huxley's statement, that Nasmyth's membrane lies on the inner side of the cells of the *membrana adamantinæ*, between these and the fibres of the enamel, has been confirmed both by M. Lent and by Mr. Tomes, it will probably be admitted to be correct; and consequently the *membrana intermedia* of Dr. Hannover, which lies *outside* the cells of the *membrana adamantinæ*, and is separated by their entire length from Nasmyth's membrane, can have nothing to do with the latter. In fact, we believe that the "*membrana intermedia*" is an entirely transitory epithelial structure, and enters in no way into the composition of the tooth.

We must express the same opinion with respect to the "stellate tissue"—Dr. Hannover's cement-germ. Dr. Hannover, after giving an account of the early changes of the epithelial lining of the dental sac, and the production of the stellate cells, in a manner not essentially different from that contained in Mr. Nasmyth's last work, seems to us to make the mistake which has already been committed by more than one writer on these subjects, of supposing the actinenchyma of the thickened wall of the dental sac to be a later stage of the stellate epithelial tissue—with which it has nothing to do, and from which it is separated by the basement membrane of the dental sac. We have in our possession figures, drawn long ago, of sections of the thickened wall of the dental sac, in all essential respects corresponding with Dr. Hannover's fig. 13; and having worked carefully over the relations of the actinenchyma (which is nothing but such connective tissue as may be met with in any soft young organ), with

the stellate tissue, we venture to speak positively on this question.

If the cement then is really developed within the actinenchyma, as Dr. Hannover describes it to be, the establishment of the fact will simply prove that his "cement-germ" (*i. e.*, stellate tissue of enamel-organ) has as little to do with the cement, as the *membrana intermedia* has with the *stratum intermedium* or Nasmyth's membrane.

It may be worth while, before concluding this notice, to consider in a few words the present state of our knowledge of the development of the teeth.

In an essay published in this Journal some years ago (vol. i, p. 149), Prof. Huxley endeavoured to prove that all the dental tissues, whether cement, enamel, or dentine, are developed beneath the basement membrane of the dental sac, which, on the dental papilla itself, has received the name of *membrana preformativa;* and that the so-called enamel-organ—consisting from within outwards of the *membrana adamantinæ,* the *membrana intermedia* of Hannover, the stellate tissue, and the deep layer resembling the *membrana intermedia,* next the basement membrane of the sac—was to be regarded as a transitory epithelial structure, which has as little connection with the development of the tooth as the various modifications of the epithelium of the root-sheath of a hair have with that of the shaft of the hair.

Evidence was offered, 1st, that the enamel-fibres, from their first appearance, lie beneath Nasmyth's membrane. 2dly. That Nasmyth's membrane is continuous with the *membrana preformativa.* 3dly. That no traces of cells or endoplasts can be discovered within the enamel-fibres nor in the dentine, and that these tissues are not produced by the direct calcific conversion of pre-existing elements. 4thly. That the cement is morphologically the continuation of the enamel, but whether it is or is not developed by conversion from the pulp was left an open question.

The first of these statements has received full confirmation from subsequent observers, including M. Leydig, in his recently published, valuable 'Lehrbuch d. Histologie,' p. 291.

The second assertion has been confirmed by M. Lent, and is not directly controverted in Mr. Tomes's paper on the Development of the Enamel, published in the 15th number of this Journal.

The third statement appears to be justified whenever writers on this question state what they have observed, and not their conclusions from their observations. We are not

aware that any one has as yet absolutely seen endoplasts or their remains in distinctly formed or forming enamel or dentine.

Mr. Tomes, in the excellent essay we have cited, endeavours to prove that Nasmyth's membrane is formed by the union of the ends of the cells of the *membrana adamantinæ*, which coalesce into a membrane; and this view would undoubtedly relieve one of much difficulty in understanding the formation of the enamel, and would bring it nearly into the same category as that of molluscan shell; but until it can be shown that Nasmyth's membrane is not continuous with the *membrana preformativa*, and is not an alteration of it, we must adhere to the view that the enamel is, like the dentine, formed under the *membrana preformativa*. Hitherto no one has attacked this side of the argument, nor has the evidence derived from the obvious continuity of the *membrana preformativa* over the whole surface of the teeth in fishes and *Amphibia* been in any way shaken. T. H. H.

ZOOPHYTOLOGY.

Class. POLYZOA.

Sub-order. *Cheilostomata.*

Fam. *Salicornariadæ.* Busk.

Gen. *Onchopora,* Busk. ('Quart. Journ. Micr. Sc.,' vol. iii, p. 320.)

1. *O. Sinclairii,* n. sp. Busk. Pl. XV, figs. 1, 2, 3.

Cells ovate, ventricose, attenuated at the bottom, slightly keeled in front, the upper part of which is occupied by a scutiform area, having in the centre a lunate pore; mouth large, sub-orbicular, the lower lip nearly straight; surface smooth; ovicell raised, globose, large, with a prominent central umbo, from which costæ radiate on the sides and summit.

Hab. New Zealand, *Dr. Sinclair, Dr. Lyall.*

The characters of the genus Onchopora will require to be altered to admit the present form, which is obviously too closely allied with those previously included in it, and especially with *O. mutica,* to allow of their being separated. The alteration will consist in the omission of the last part of the character given as above, or that referring to the ovicell, which in the present species is very large and peculiarly marked.

The polyzoary of the present species, which has something of the habit of a *Salicornaria,* is constituted of cylindrical branches of various lengths and usually dividing dichotomously. The whole forms a more or less dense rounded tuft.

2. *Lepralia,* Johnst.

1. *L. thyreophora,* n. sp. Busk. Pl. XV, figs. 4, 5.

Cells ovate, upper half in front occupied by a scutiform area, in the centre of which is a lunate pore, and on either side a single row of punctures (?) which also extends across the front of the cell immediately below the mouth, which is rounded above with a straight lower lip; ovicell lofty, rounded, faintly punctated.

Hab. New Zealand, *Dr. Sinclair.*

This Lepralia, which is parasitic upon *O. Sinclairii,* in some respects resembles *L. Malusii* (B. M. Cat., pl. 103), differing from it, however, in its having a distinct scutiform area on the front of the cell, and in the arrangement of the apparent perforations or puncta, which exist only around the margin of the scutiform area and across the upper border of the cell, whilst in *L. Malusii* the entire front of the cell, except in the centre, is punctated.

Another species with which the present might also be confounded, and from which it appears to differ only in the absence of oral spines—is the *Escharina cornuta* of D'Orbigny ('Voy. à l'Amer. occid.,' plate v).

2. *L. Cecilii*, Audouin, Exp. I, p. 239. Pl. XV, figs. 6, 7.
Savigny, Egypt, pl. ix.

Cells ovate, with a central umbo, surface punctate; mouth rounded above, with a straight lower lip, in the middle of which is a narrow sinus; ovicell raised, surface granulose.

Hab. Jersey, *Mrs. Buckland.*

This large and beautiful species, for which the British Fauna is indebted to Mrs. Buckland, corresponds so closely with Savigny's figure of *L. Cecilii*, that there can be little doubt of the two being identical.

Sub-kingdom. CŒLENTERATA.

Class. HYDRAZOA.

Order. *Hydroida.*

Fam. *Sertulariadæ.*

Gen. *Cryptolaria*, n. g. Busk.

Cells completely immersed in a cylindrical polypidom, composed of numerous tubes.

1. *C. prima*, n. sp. Busk. Pl. XVI.

Sp. unica.

Hab. New Zealand, *Dr. Sinclair.*

This curious Sertularian appears to constitute a peculiar type of the family to which it belongs.

The specimen from which the description and figures were made, collected by Dr. Sinclair in New Zealand, and now in the British Museum, is about six inches high, and consists of a single central stem or rachis, with alternate branches on either side in the same plane, and which become shorter as they approach the summit. The lower part of the rachis or stem is toothed on each side, the teeth evidently representing the roots of branches which have been broken off. Towards the lower part of the pinnate portion, one or two small branches also simply pinnate may be seen springing from the main stem.

The stem and branches are composed of small tubes; and the cells are completely immersed among these tubes; the mouth even, being depressed below the surface, and presenting itself in the upper part of an elongated pit, surrounded with a raised border, which arches above the mouth of the cell.

The cells are disposed in longitudinal series, one above the other—but alternate with each other in the contiguous series. The mouth of the cell is contracted, circular, and simple.

On a New Species *of* Bugula. By Joshua Alder, Esq.

Bugula turbinata, Pl. XVII, figs. 1—4.

Polyzoary orange-coloured or yellowish, paler when dry; one to two inches high, forming an ascending spiral, the branches dividing dichotomously, truncated at top, and arching outwards. Cells in two to five series, elongated, the aperture reaching nearly to the bottom; a single erect spine at each upper angle. Avicularia of two sizes, those on the outside moderately large, with a rounded head, and a short back abruptly bent at the point; situated on the upper part of the margin of the cell; inner avicularia small. Ovicapsules subglobose, with a rim rising into a peak in front.

Cellularia avicularia, Pallas, 'Elench. Zooph.,' 68 (?).
Gosse, 'Ramb. Dev. Coast.,' p. 195, t. x.

This species has hitherto been confounded with *Bugula avicularia*, to which it bears a strong resemblance, but is nevertheless quite distinct. In its mode of growth it is rather more robust than that species, and may readily be distinguished from it by the number of cells increasing to three, or occasionally even to five longitudinal rows in some of the branches; in *B. avicularia*, there are never more than two throughout. On examining the two kinds microscopically, other differences are found. The cells in *B. turbinata* have invariably only a single large spine on the outer angle; *B. avicularia* has two spines, as correctly represented by Professor Busk,* though the smaller one has been frequently overlooked. The avicularium is rather smaller in *B. turbinata* than in *B. avicularia*, and has the head more rounded, and the beak much shorter and more abruptly bent at the point (fig. 4). It is also set higher up on the margin of the cell, frequently close below the spine. The ovicapsule in this species is smaller, and has a border generally rising into a peak in front.

The only published figure of this species that can be recognised with certainty is that of Mr. Gosse, in his interesting 'Rambles on the Devonshire Coast,' where it is well described under the name of *Cellularia avicularia*. The magnified figures G, H, pl. xxxviii of Ellis's 'Corallines,' would seem to represent this species, having only a single

* 'Catalogue of Marine Polyzoa,' pl. liii.

spine on each angle of the cell, but the small figure (7) is more like *B. flabellata*, to which it has been usually referred. Pallas describes his *Cellularia avicularia* with three to five longitudinal series of cells, and a single spine at each upper angle; characters which taken together only belong to *B. turbinata*, and the general accuracy of his descriptions favour the supposition that he had this species in view; his var. β being probably *B. flabellata*, to which *Crisia flustroides* of Lamouroux, and *Flustra angustiloba* of Lamarck, may also be referred, though the former author describes only a single spine at each angle of the cell: this is likewise the case in Dr. Johnston's description of *Flustra avicularia*, but his figure more correctly shows two or three spines on each side. The *Cellularia avicularia* of Van Beneden is evidently *B. flabellata*.

B. turbinata appears to be quite as common on the British coast as *B. avicularia*, if not more so. It occurs principally within tide-marks, or in shallow water. The finest specimens I possess were got under stones at low-water mark in the island of Herm. They were of a deep orange colour when alive. I have met with it at Guernsey and in the Menai Straits, and have had it sent from Falmouth by Mr. Cocks. Mr. Hincks informs me that it is the common species on the Devonshire and Yorkshire coasts; and Mr. Busk has favoured me with the examination of a specimen sent from Tenby by Mr. Dyster. It has not yet occurred on the Northumberland coast, nor can I trace it into Scotland, but it would be premature at present to fix any limits to its range.

On some New British Polyzoa. By the Rev. T. Hincks.

The new British Polyzoon which I am about to describe is, in many points, so nearly related to the well-known *Scruparia chelata*, that I have determined to rank it in the same genus with this species, although the generic character, as given by Mr. Busk in his 'Catalogue,' must be revised to allow of its admission.

Polyzoa Infundibulata.

Sub-order. *Cheilostomata.*

Fam. *Scrupariadæ.*

Gen. *Scruparia*, (Oken).

Polyzoary erect, branching, subcalcareous; cells clavate; apertures on one aspect, oblique, subterminal.

S. clavata, Hincks, n. sp. Plate XVII, figs. 5, 6, 7, 8.

Cell slender, elongate, enlarged upwards, tapering off below; aperture subterminal, oval; branches given off from the back of a cell; ovicelligerous cells placed back to back with the ordinary cells.

Polyzoary sparingly branched, the branches originating from the back of a cell; cells ovate-elongate above, and tapering off below, each one springing from behind the aperture of another, and attached to it by a somewhat cordate expansion of the base; aperture oval, small as compared with that of *S. chelata*, and not marginated. The position of the ovicelligerous cells is very peculiar. They are (generally) attached to the back of the ordinary cells, to which they are adherent throughout, and are irregularly distributed over the polyzoary. Occasionally they occur *at the side*. They are inferior in size to the ordinary cells. The ovicell is of the usual form.

The polypide has, I believe, about ten arms.

Dredged off Filey, on the Yorkshire coast, parasitical on *Crisidia cornuta*; not uncommon. Lamlash Bay, Arran.

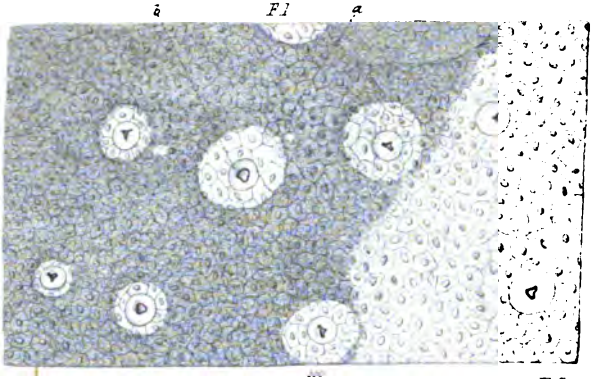
Sub-order. *Ctenostomata.*

Fam. *Alcyonidiadæ.*

Sir John Dalyell, in his work on 'Rare and Remarkable Animals of Scotland,' has described and figured an *Alcyonidium* under the name of *A. Mytili*. The species has escaped the notice of Dr. Johnston, and is not included in the 'History of the British Zoophytes.' Sir J. Dalyell's description displays his accustomed accuracy, so far as it goes, but he did not observe the ovaries, and his account of the species is therefore necessarily incomplete. The name which he has assigned it is altogether inappropriate, and conveys a false impression, inasmuch as the species is by no means a parasite of the Mussel exclusively, but is found encrusting *Fuci*, stones, and shells of various kinds. It is manifestly undesirable that such names should be retained, and I therefore propose to change it. I do this with the less hesitation, because the species has thus far attracted very little attention, and Sir John Dalyell's name for it has not obtained a footing in our nomenclature.

Alcyonidium hexagonum, Hincks. (*A. Mytili*, Dalyell, 'Rare and Remarkable Animals,' vol. ii, p. 36.)

Encrusting, fleshy, of a dingy-white colour, composed of hexagonal cells, the septa of which show distinctly on the surface, and thickly covered with small obtuse prominences.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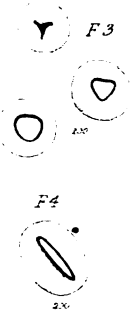
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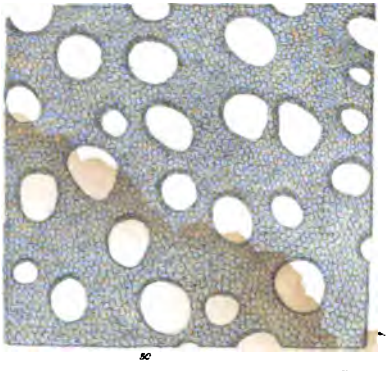
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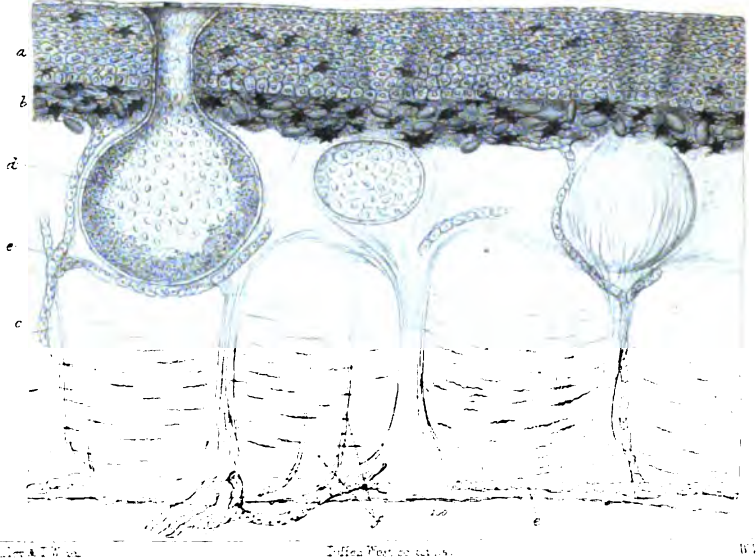
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DESCRIPTION OF PLATE VI,

Illustrating Dr. Harley's paper on Cutaneous Respiration.

Fig.

1.—The deep and superficial layers of the epidermis of the Frog's skin.
   a. Epithelium covering the openings.
   b. Central cell, with aperture.

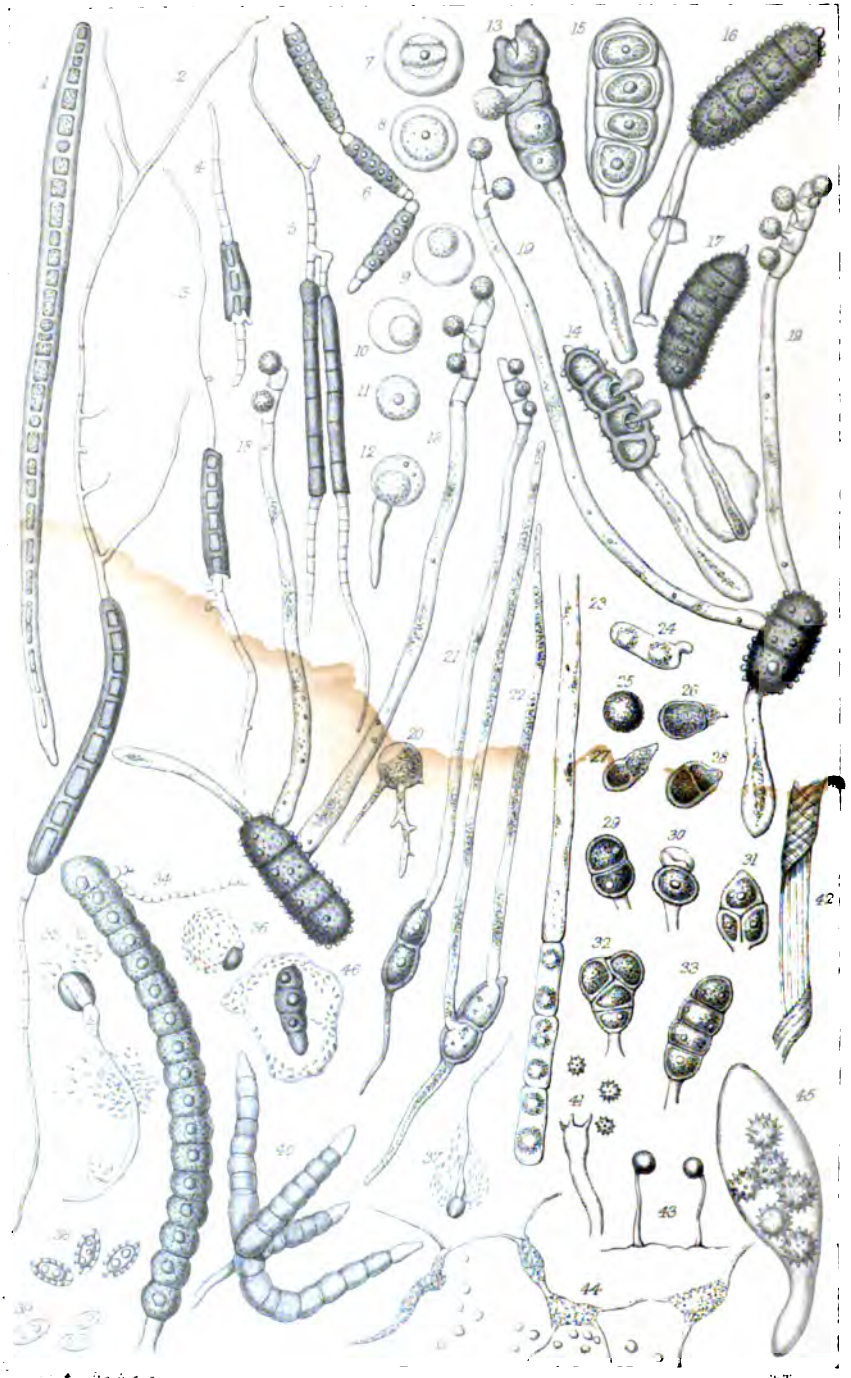
2.—Deep layer of epidermis, showing the arrangement of the openings.

3.—Central cells, containing the triangular apertures in different stages of enlargement.

4.—Oval opening in the central cell of the Water-Lizard.

5.—Cutis vera of the Frog.
   a. Lining membrane of the air-passage.
   b. *Peculiar bodies*, resembling in some respects Pacinian corpuscles.
   c. Pigment-cells.
   d. Termination of the spread-out ends of the perpendicular fibres.

6.—Transverse section of the Frog's skin.
   a. Epidermis.
   b. *Peculiar bodies* distributed among the pigment-cells.
   c. Cutis vera.
   d. The air-cavities, cut through in different parts.
   e. Blood-vessels.
   f. Nerves.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DESCRIPTION OF PLATE VIII,

Illustrating Mr. Currey's paper on some points in the Structure and Physiology of certain Fungi.*

Fig.

1.—A spore of *Helminthosporium Smithii.*

2.—A spore of the same plant germinating.

3, 4.—Fragments of similar spores germinating.

5.—Fragments of two of the vegetative threads of the same plant protruding filaments similar to germ-filaments. The filaments from the two upper ends have become united in growth.

6.—Spores of *Helminthosporium fumosum.*

7 to 11.—Various states of the cells constituting the so-called joints of the fruit *Phragmidium bulbosum* after their escape from the enveloping membrane under the action of heated nitric acid.

12.—The bottom internal cell and the internal stem-cell of a fruit of *Phragmidium bulbosum.*

13.—A fruit of *Phragmidium bulbosum* which has been subjected to hydrochloric acid and then ruptured by pressure, showing the escape of one of the inner cells.

14.—A similar fruit, under the action of hydrochloric acid, showing the spontaneous protrusion of two of the inner cells.

15.—A similar fruit in which the outer membrane or ascus has become swollen and separated from its contents by the action of heated nitric acid.

16.—A similar fruit, after having been soaked in water for some hours, exhibiting the internal stem-cell.

17.—A fruit of *Phragmidium mucronatum* under the same circumstances.

18, 19.—Fruits of *Phragmidium bulbosum* in germination.

20.—One of the so-called "sporidia" produced by a germinating filament of *Phragmidium bulbosum* which has become detached and commenced germination on its own account (magnified 420 diameters).

* Except where it is otherwise mentioned, all the figures are magnified 220 diameters.

PLATE VIII (*continued*).

Fig.

21.—Fruit of *Puccinia graminis* germinating and producing globose "sporidia."

22.—Fruit of *Puccinia Lychnidearum* germinating (magnified 315 diameters).

23. –Peculiar germination observed in *Triphragmium Ulmariæ*. (The figure only shows a portion of the germ-filament, magnified 420 diameters.)

24.—A joint of the above filament of *Triphragmium Ulmariæ* which has separated itself and commenced germination.

25 to 33.—Various forms of fruit of *Phragmidium Potentillæ*.

34.—Fruit of *Xenodochus carbonarius*.

35, 36, 37.—Spores of a species of Gymnosporium in germination.

38.—Spores of *Peziza aurantia*, exhibiting the peculiar germination referred to in the text.

39.—Spores of *Peziza aurantia* in their ordinary state.

40.—Spore of a species of Triposporium.

41.—Filament of *Zygodesmus fuscus*, showing the sterigmata at the apex. On the right hand are three spores detached.

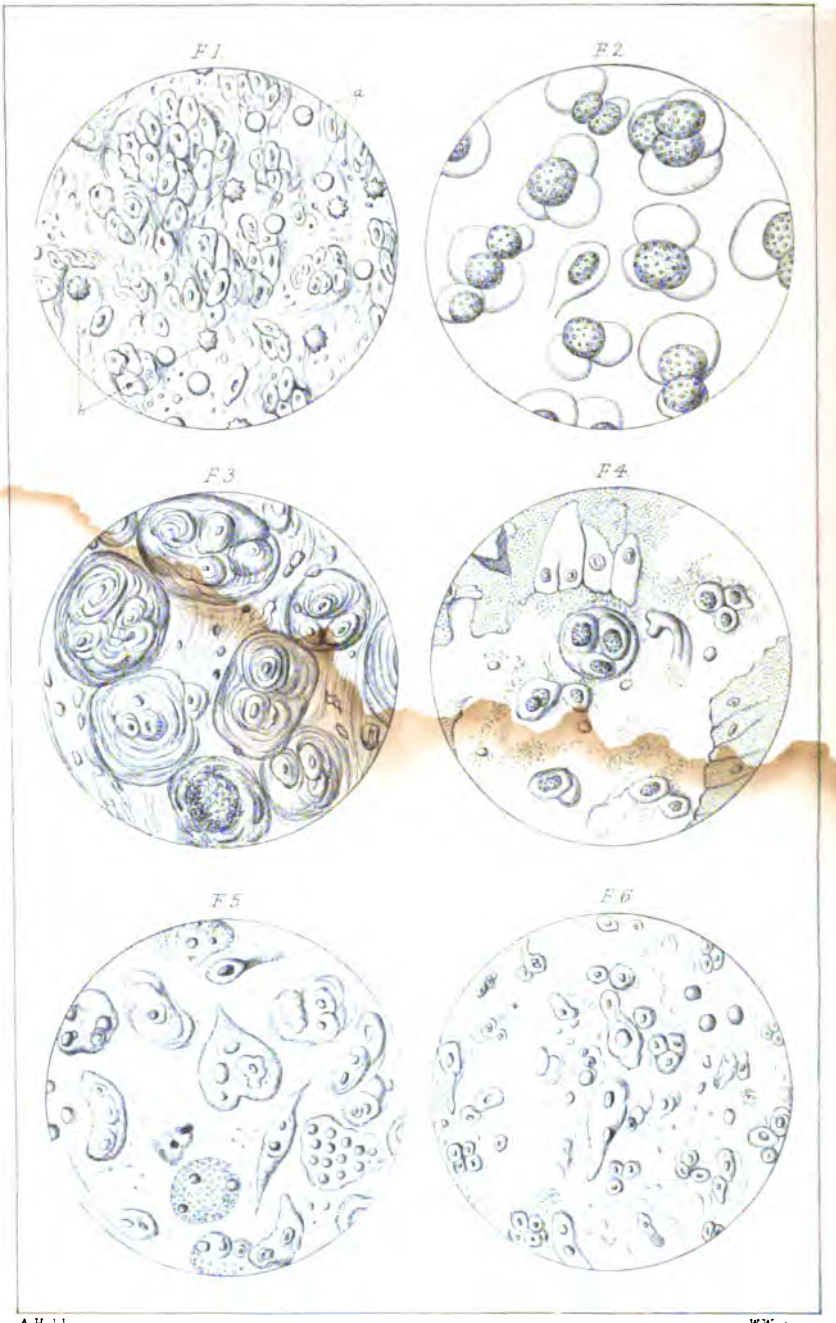
42.—A fragment of the capillitium of *Trichia turbinata* acted on by hydrochloric acid, showing the mode of spiral unrolling of the membrane and the five internal bands (highly magnified, but to no particular scale).

43.—Two specimens of a doubtful *Trichia* (slightly magnified).

44.—A portion of the capillitium and some spores of the last-mentioned plants.

45.—Ascus and sporidia of *Choiromyces meandriformis*.

46.—Sporidium of *Sphæria Amblyospora* giving out small colourless cellules into its gelatinous envelope.



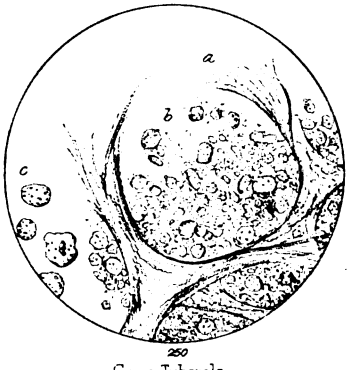
A. H. del.

W. West imp.

Fig 1

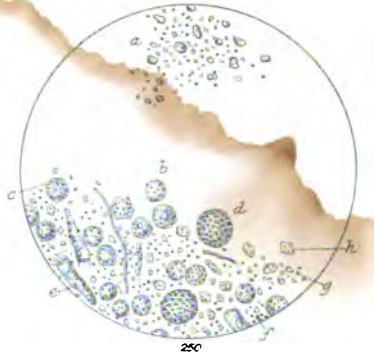
Yellow Tubercle

Fig 2



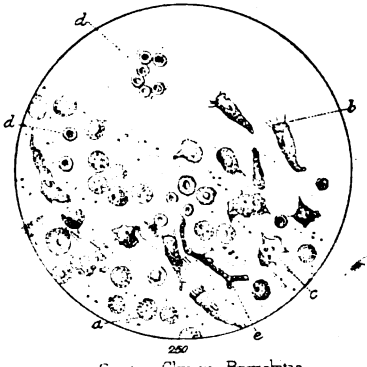
Gray Tubercle

Fig 3.



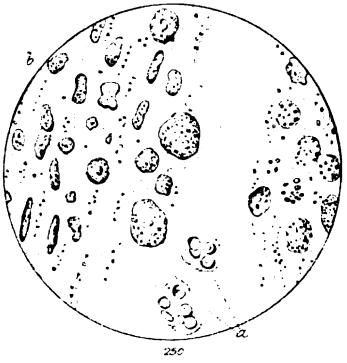
Yellow Tubercle liquefying

Fig 4



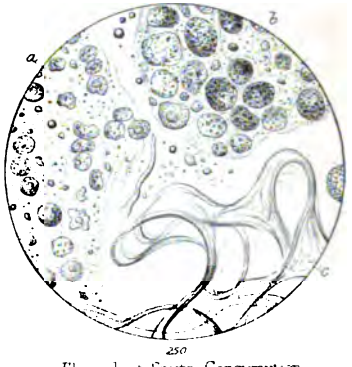
Sputa. Chronic Bronchitis.

Fig 5.



Gelatinous Sputa, Consumption

Fig 6.



Flocculent Sputa, Consumption

Tuffen West sculp. et lith.

W. Wise imp.

DESCRIPTION OF PLATE IX,

Illustrating Mr. Hepworth's paper on Compound Nucleated Cells.

Fig.

1.—Epithelial scales from kidney, after desquamation of the tubuli uriniferi.
   a. Blood discs.
   b. The same altered by exosmosis.
2.—Compound cells from cyst of ovarian dropsy.
3.—Nucleated cells from cancroid tumour of the brain.
4.— Ditto from forearm of an old woman, aged 83.
   a. Epithelial scales.
5.—Nucleated cells from mamma.
6.— Ditto from uterus.

PLATE X,

Illustrating review of Dr. Hall's work on Thoracic Consumption.*

1.—Yellow tubercle.
   a. Tubercle corpuscles.
   b. Simple tubercle cells.
   c. Granular matter in quantity.
   d. Curled elastic tissue.
2.—Gray tubercle.
   a. Elastic tissue of the air-cells.
   b. Tubercle elements.
   c. Compound tubercle cells, and epithelium in a state of fatty degeneration.
3.—Yellow tubercle liquefied.
   a. Fluid of a creamy consistence from the centre of crude yellow tubercle. Small tubercle corpuscles, granules, and oil in a state of minute division.
   b. Pus-like fluid from yellow tubercle completely liquefied.
   c. Pus-cells.
   d. Granule cells.
   e. Columnar epithelium.
   f. Oil molecules.
   g. Free granules.
   h. A few single tubercle corpuscles.
4.—Sputa from chronic bronchitis.
   a. Pus and mucus.
   b. Bronchial columnar epithelium.
   c. Shrivelled and abortive cells.
   d. Blood corpuscles; some of these appear to have a delicate envelope.
   e. Leptomitus (a minute fungus).
5.—Gelatinous sputa, consumption.
   a. Enveloped blood corpuscles.
   b. Cells with a few granules, molecular matter, and oil.
6.—Flocculent sputa, consumption.
   a. Pus and mucus, shrivelled cells, with irregular edges, granular matter, and oil.
   b. Group of cells, with pigment; probably from one of the bronchial glands.
   c. Curled elastic fibre.

* All the figures on this plate are enlarged 250 diameters.

ZOOPHYTOLOGY.

DESCRIPTION OF PLATES.

PLATE XV.

Fig.
1.—*Onchopora Sinclairii*, natural size.
2, 3.—Magnified figures of the same.
4, 5.—*Lepralia thyreophora.*
6, 7.—*Lepralia Cecilii.*

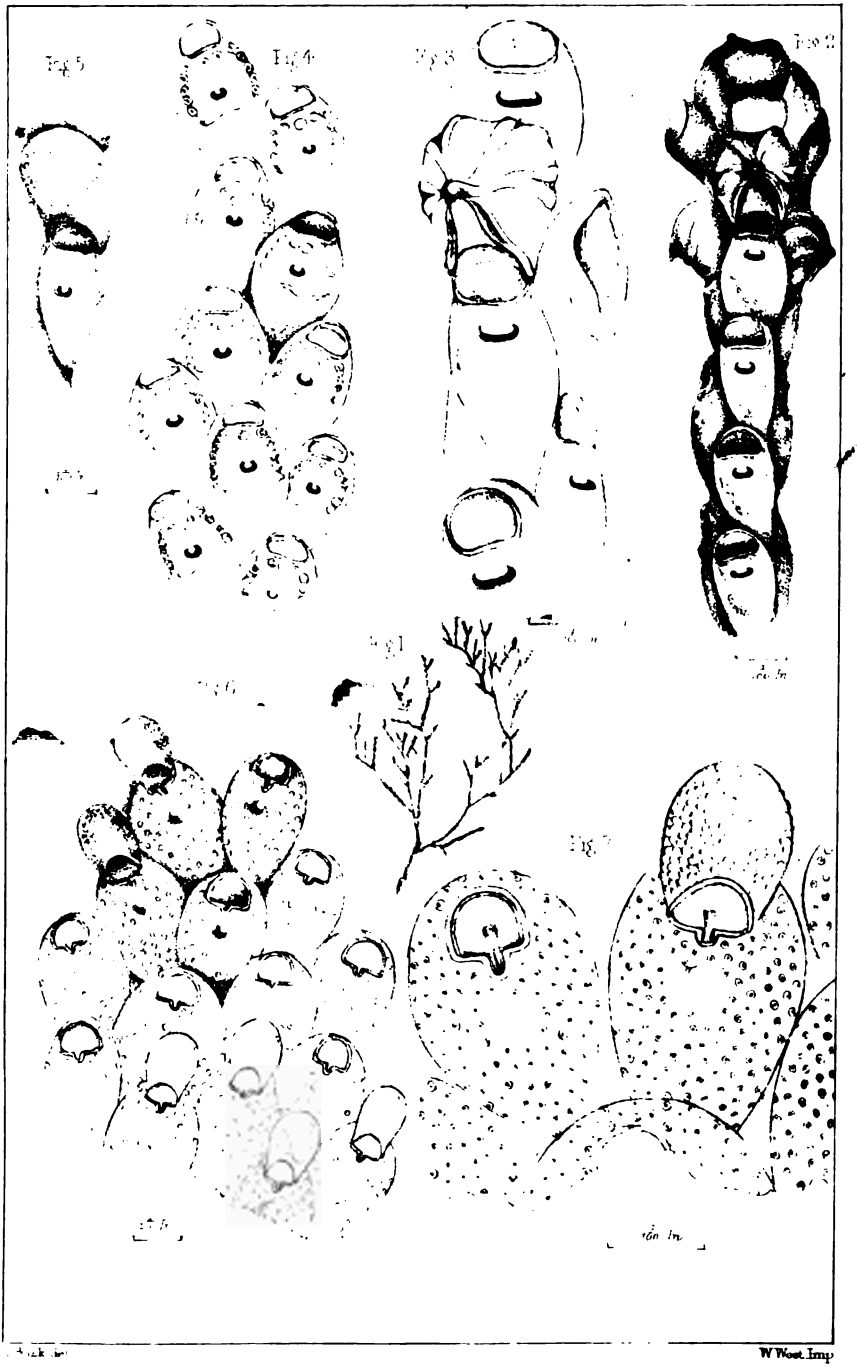
PLATE XVI.

1.—*Cryptolaria prima*, half natural size.
2, 3.—Portions of a branch.
4.—Section of ditto.

PLATE XVII.

1.—*Bugula turbinata*, natural size.
2.—Front view.
3.—Back view.
4.—Ovicell.
5, 6, 7.—*Scrupuria.*

Plate XV



W West Imp

Plate XVI.

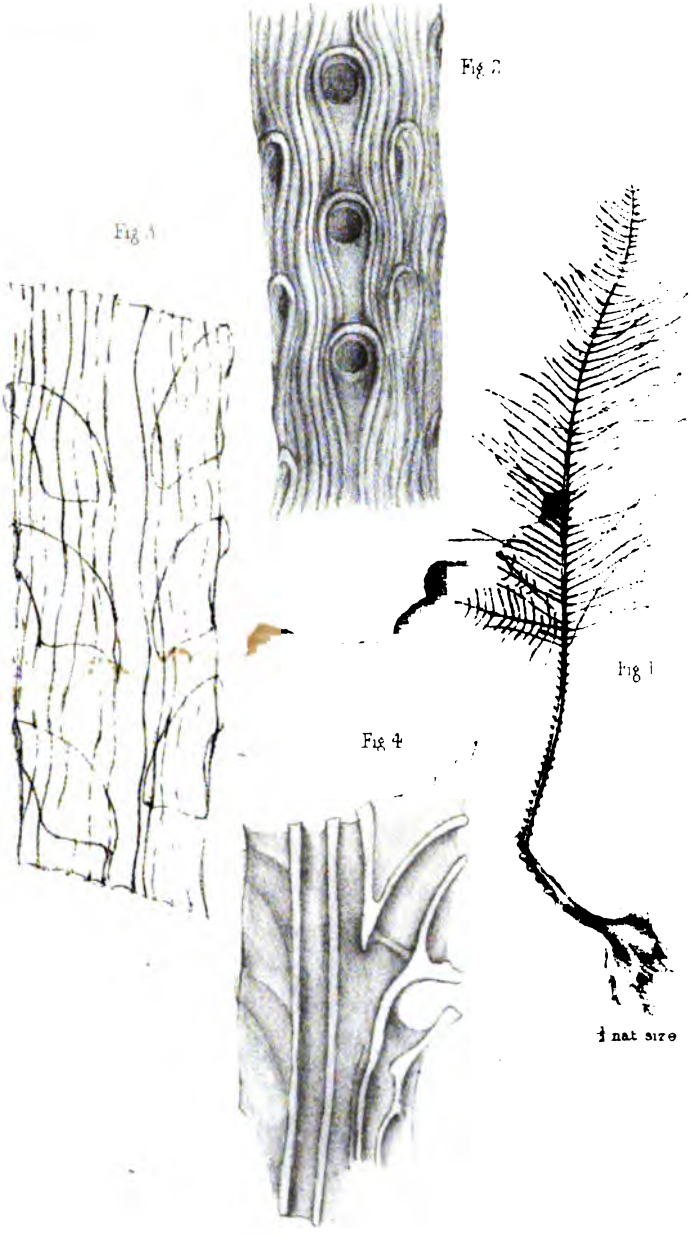
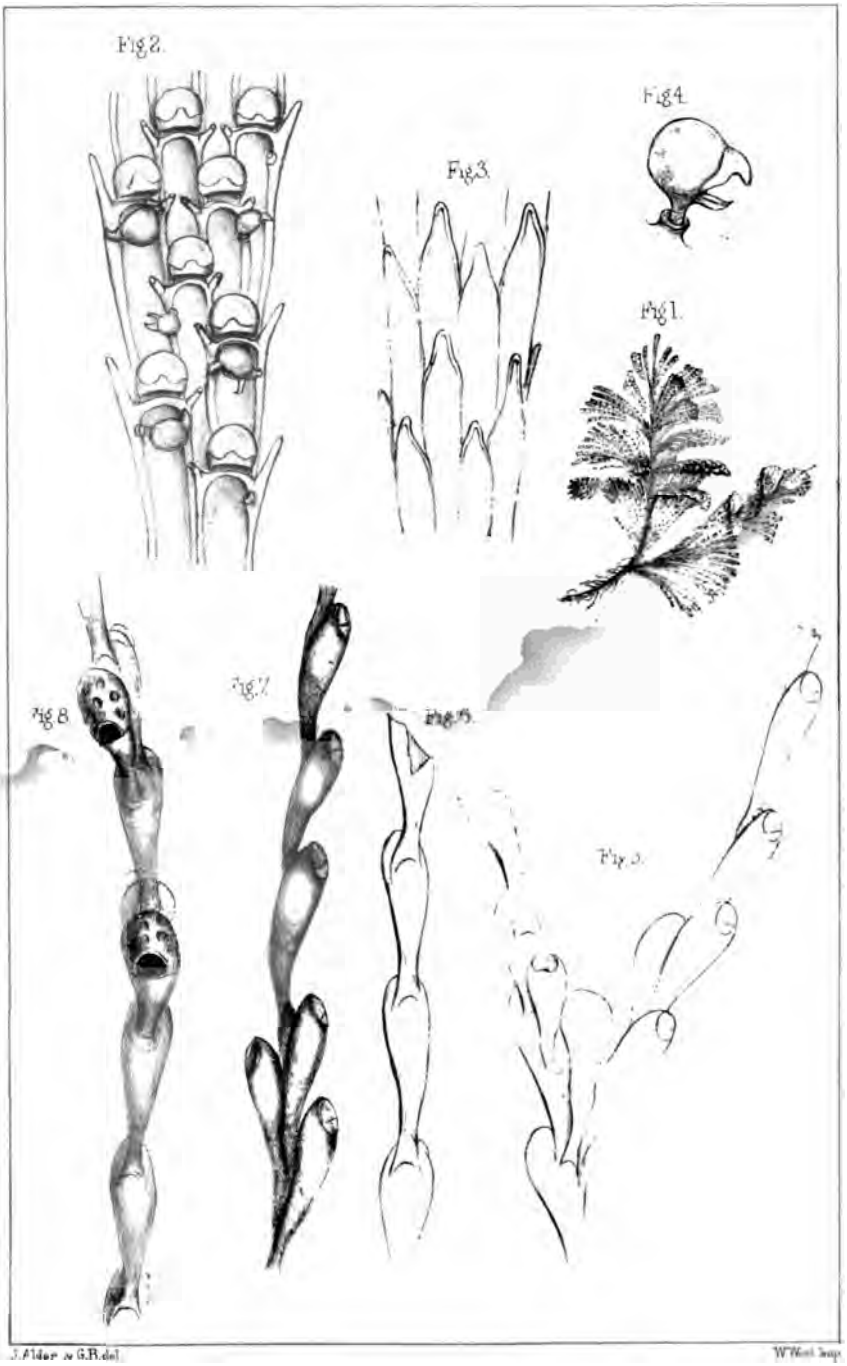


Plate XVII.



J. Alder & G.B. del.

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ORIGINAL COMMUNICATIONS.

On the Structure *of* Lecidea lugubris (Sommf.)

By W. Lauder Lindsay, M.D., Perth.

While engaged in lichenological studies in the Braemar Highlands during the summer of 1856 (August), I met with a beautiful little lichen, which has not hitherto, I believe, been detected in Britain, and which appears also to be very rare on the continent of Europe. It was the *Lecidea lugubris* of Sommerfeldt ('Suppl. Lapp.,' 143, and Schærer's 'Enumeratio Critica Lichenum Europæorum,' Bern, 1850, p. 101); and the *Schæreria lugubris* of Körber ('Systema Lichenum Germaniæ,' Breslau, 1856, p. 232). I was further fortunate enough to find specimens bearing not only apothecia, but spermogones; the latter organs not having apparently been hitherto discovered or described. The structure of the apothecia is exceedingly beautiful; and the peculiar spores serve to distinguish this species from all other British Lecideæ. The facts that the structure of this lichen is probably, in great measure, unknown to British lichenologists; that the plant has not hitherto been found in Britain, while it is a rare alpine continental species; that its spermogones have not been heretofore, so far as I am aware, discovered or described; and that its spores serve to distinguish it from all other British Lecideæ—induce me to offer the following account of its external characters and minute anatomy, based on my examinations of specimens collected at Braemar.

The *Lecidea lugubris*, Sommf., is placed, and very properly I think, by Schærer ('Enum.,' l. c.) in the section *Psora* of the genus *Lecidea*,—this section being characterised by the possession of a squamulose thallus; and in the subsection thereof in which the squamules are often aggregated or crowded into a plicate or areolate crust. Its external characters place it in near affinity to the more familiar *Lecidea cæruleo-nigricans*, Sch. (Schær., 'Enum.,' 101, Lich. Helvet. exsicc., 168). It also bears a resemblance, in some particulars, to *L. decipiens*, Ach. (Schær., 'Enum.,' 95, L. H. E., 164, and plate v, fig. 2; *Biatora decipiens*, Ehrh., Hepp, 'Die Flechten Europas,' 1853, 120; Tulasne, Mém. pour servir à l'histoire organographique et physiologique des Lichens,

'Ann. des Sc. Naturelles,' 3d ser., v, 17, 1852, plate x, figs. 28—30), and to *L. lurida*, Ach. (Schær., 'Enum.,' 96, L. H. E., 157; *Biatora lurida*, Sw., Hepp, 121); but it differs from them in its squamules being comparatively simple and aggregated, and in the apothecia being black, flat, and margined throughout. The lichenological student may further compare it, in regard to its general external characters, with *Psora* (*Lecidea*) *scalaris*, Hook, of Smith's 'Engl. Bot.,' vol. xi, p. 2, plate 2113 (2d. ed., 1844); in regard to the relative position on the squamules of the spermogones and the apothecia, with *Endocarpon sinopicum*, Wahl. (Tulasne, Mém., pl. x, figs. 19, 20); and in regard to the characters of the thecæ and spores with *Sphærophoron coralloides*, Pers. (Tulasne, Mém., pl. xv, fig. 4), and *Calicium turbinatum*, Pers. (Tul., Mém., pl. xv, fig. 15). Fries places it between his *Lecidea atro-alba* and *L. panæola*.

While Schærer has classified it according to its thallus, Körber has arranged it according to its spores. The latter places it in his sub-family *Lecidinæ* of the family *Lecideæ*, the latter being divided by him into three sub-families, and no less than thirty-two genera, which were formerly chiefly included in the single, but comprehensive, genus *Lecidea!* His Lecidinæ are characterised by possessing a crustaceous uniform thallus and lecidinic apothecia—black, not coloured, and having a proper exciple, formed of a tissue differing in colour from the thallus. He arranges it between his genera Catillaria and Lecidella, and near the genus Lecidea. The differential diagnosis between these is founded on the fact that Catillaria has two-locular, hyaline spores; and that Lecidella and Lecidea have ovoid or ellipsoid spores in subclavate thecæ, the latter genus possessing also a simple, carbonaceous hypothecium. But Körber constitutes this lichen the type of a new genus, on which he bestows the honoured name of Schærer—the great Swiss lichenologist (*Schæreria lugubris*, 'Syst. Lich. Germ.,' l. c.) "Den Manen," he remarks, "des vortrefflichen um die Wissenschaft aüsserst verdienten Schweizer Lichenologen Schærer widme ich diese durch ihren Fruchtbau hervorragende Gattung, die in vieler Beziehung ein Uebergangsglied zwischen den psorinischen und lecidinischen Flechten darzustellen scheint." ('Syst. Lich. Germ.,' p. 232.) The essential characters of his genus Schæreria are the globose spores, contained in linear thecæ, and the simple, brownish hypothecium.

I have every wish that the illustrious name of Schærer should be honoured in the description of really new species, for I think it is at least as little objectionable to employ the

names of celebrated botanists to distinguish species as to bestow many of the present absurd adjective terms, which imply no structural peculiarities or natural affinities, but merely some far-fetched, and perhaps invisible or unintelligible resemblance or analogy. But I cannot regard the characters of the spores as sufficient to constitute *Lecidea lugubris* the type of a new genus, by whatever name it may be called. If we classify on this principle, we shall infallibly, as Körber has done, split up or subdivide the Lecideæ—and lichens in general—into an endless and most confusing number of new genera and species. I regard the characters of the spore as an invaluable assistance in specific diagnosis; and I quite agree with Körber that, in regard to its spores, this lichen stands conspicuously by itself among the Lecideæ. I think it, however, in classification, sufficient to place it under a separate subdivision, headed "*Spores globose*," without creating a new genus for its special accommodation. The lichen possesses no external characters to justify such an isolation and distinction. I, therefore, prefer retaining the plainer and less euphonious name originally bestowed on it by Sommerfeldt—*Lecidea lugubris*. I do so as a practical protest against the modern spirit of name-manufacture, and of the fastidiously elaborate subdivision of genera and species. This is probably the result of a mono-ideaism; I shall not say a morbid one, but one which is apt to lead to a repulsively minute and difficult classification. By seizing upon one particular structural feature, as a guiding principle of classification, we are too apt to lose sight of natural affinities, and so fall into all the evils of artificiality.

Before entering upon the details of minute anatomy, I shall give the amended specific characters of *L. lugubris*, Sommf.—founded on those of Schærer and Körber. Neither of these authors, however, makes any reference to the spermogones.

Lecidea lugubris, Sommf. emend.—*Sp. char.* *Thallus* cartilaginous; olive- or reddish-brown; sub-effigurate; consisting of a series of sub-lobulate squamules, aggregated into an areolate crust. *Hypothallus* black. *Apothecia* sessile; black, naked; thalamium flat; margin sub-prominent, and consisting of a black or brownish-black, waxy, cup-shaped, proper exciple. *Hypothecium* brownish, sub-grumous, simple. *Thecæ* eight-spored; sub-linear, long, delicate; tapering below into a narrow longish pedicle. *Paraphyses* lax,

wavy, very slender; barely equalling in length the thecæ; tips deep indigo blue. *Spores* arranged in linear series in thecæ, sub-minute, simple, globose, margined; nucleus pale yellow. *Spermogones* scattered, punctiform, immersed, sub-spherical, simple. *Sterigmata* simple, sub-linear; somewhat irregular in form; generating from their apices straight, rod-like *spermatia*.

Syn. Lecidea, sp., *Sommf.*, Suppl. Lapp., 143.
Schær., Enum., 101.
Fries, Lichenographia Europæa reformata, 1831, 314.
Rabenhorst, Die Lichenen Deutschlands, 1845, 83.
Schæreria, Körb., Syst. Lich. Germ., 232.

Hab. On weathered gneissic boulders, moor immediately to the west of the village of Braemar, Aberdeenshire. Coll. August, 1856.

Körber mentions, as the habitat of this lichen, primitive rocks on high mountains (above 3000 feet of elevation); stating that it is very rare. He gives only two stations for it,—one in the Riesengebirge (Flotow), and the other on the Bavarian mountains (Krempelhuber). Schærer again gives, as its habitat, subalpine rocks in Sweden, and other parts of northern Europe (Sommf., Blytt, and Flotow). The station in which I found it could not be said to be alpine. It was the low ground—a moor—immediately to the west of the Free Church School-house of Braemar, within half a mile of the village, and to the south of the high road leading to the Linn of Dee.

It grew sparingly on some weather-worn gneissic boulders. The principal rocks in the neighbourhood are gneiss, granite, and mica slate. I did not meet with it at all on the neighbouring mountains, which include some of the highest in Scotland (Ben Mac Dhui, 4296 feet; Brae-riach, 4280; Cairntoul, 4230; and Cairngorm, 4050). It is, however, a small lichen; and, not expecting such a rarity, I did not specially look for it. I have not hitherto found it in other parts of Scotland, notwithstanding that I have visited most of its highest mountains in the pursuit of lichenological studies (the Cairngorm range, Ben Nevis, Ben Lawers, the Coolin Range, Skye, &c.) It should in future be carefully looked for in such localities as Braemar.

The thallus generally consists of small, simple, thick, fleshy, convex, squamules, with a sub-lobulate, ill-defined edge. The colour is some shade of brown; in some cases a green tint predominating, in others a reddish. Sometimes the squamules are so minute, thick, convex, and irregular, that they have more the characters of verrucles or thalline warts. The under surface of the thallus is usually intimately adherent to its basis of support,—which is generally some of the primitive or metamorphic rocks,—gneiss in the specimens examined by me. It is found, on examination, that the surface of the rock has been disintegrated by the lichen, and that a sort of union has been formed between them; a union so intimate that it is almost impossible to cleanse the under surface of the thallus from the adherent particles of fine sand—the result of disintegration—without destroying portions of the cortical and medullary tissues of the thallus. It thus becomes difficult to see the black hypothallus upon, and from which the brownish thallus is subsequently developed. The thallus consists of the ordinary triple division of tissues—cortical, gonidic, and medullary. The cortical tissue consists of small cellules of a brownish colour. Those arranged most externally are somewhat oblong from mutual pressure, closely aggregated, and of a deep brown colour; while those placed internally are more round, of a light colour, and more loosely aggregated. The gonidia are large and distinct, and possess the usual characters. The medullary tissue consists of very narrow, delicate, indistinct, branching tubes or filaments.

The apothecia vary in diameter from the $\frac{1}{30}$ to $\frac{1}{40}$ of an inch. They are those of a true Lecidea—being flat, margined, black, and naked; the thalamium enclosed by a peculiar or proper exciple, formed of a substance differing in colour from the thallus. The thalamium is open *ab initio*, and it remains flat and open throughout. I have not observed it intumescent, so as to become convex or sub-globose, and obscuring or covering the margin or exciple; neither does the margin swell or disappear, though it may present slight irregularities in form. The apothecia are generally round; but they sometimes become, from mutual pressure, when two or three are aggregated together, somewhat angular. Though sessile, they are not attached, in their mature state, by their whole lower surface; but only by the central portion thereof. Their base of adhesion is sometimes comparatively narrow, and may become substipitate, or at least may raise the lower surface of the apothecium slightly above the upper surface of the thallus. The apothecium is sometimes

slightly roughened on its surface; but I have not been able to detect any of the scobiform dust, which occurs on the surface of the thalamium in Sphærophoron, and which is due chiefly to the accumulation of the ripe spores, along with the *débris* of the elements of the hymenium.

The *hypothecium* consists of small, roundish, or irregular cellules, of a brownish tint. From the *hypothecium* the *thecæ* arise as small oval vesicles, which gradually become, by elongation, linear-cylindrical cells, having a nearly uniform width throughout, except below, where they taper suddenly into narrow, kneed or irregularly bent and longish pedicles. The thecal cell is at first full of a pale yellowish, finely granular or grumous protoplasm. As the theca increases in size, larger granules and globules make their appearance: these become agglomerated into globular masses, which gradually assume the form of the future spores. Lastly, the cell-wall of the spore becomes visible, and is separated by a hyaline, distinct margin from the globular nucleus, which is of a pale yellow colour. For a considerable period the spores are glued together in a linear series, somewhat after the manner of the spores of Sphærophoron and some Calicia. Here, however, the spores appear to attain to perfect maturity before they escape from the theca. Here, also, the spore-sac may generally be seen with tolerable distinctness, closely lining the interior of the thecal cell, at almost every stage of the development of the theca. Nor is the thecal wall ever so delicate in *Lecidea lugubris* as to be invisible, as in certain Calicia (*e. g.*, *C. tympanellum*, Ach., Tulasne, Mém., pl. xv, fig. 18). Mature thecæ generally measure from $\frac{1}{300}$ to $\frac{1}{280}$ inch,—the average being $\frac{1}{250}$—in length, by about $\frac{1}{2000}$ in breadth. They generally come off from the hypothecium in groups or bundles, six or eight thecæ being closely aggregated, and the several groups of thecæ are separated by similar bundles of paraphyses. They usually equal in length the paraphyses, and frequently project beyond them. When full of mature spores, the theca is a very beautiful object under the microscope: it may be likened to a narrow, colourless glass tube, containing a string of yellowish beads, of nearly the same diameter as the tube. The theca, when mature, becomes ruptured at the apex, giving escape to the spores one by one: these do not accumulate on the surface of the thalamium as in Sphærophoron. Under the reaction of iodine, the theca assumes a pale blue colour; but this tint is not much better marked at the apex than below. This colour, struck by iodine, is indeed much darker and more distinct among the groups of paraphyses, which separate the

bundles of thecæ,—the amylaceous substance producing the reaction being probably a gummy intercellular matter, which cements the elements of the hymenium. While the paraphyses are somewhat vividly, and the thecæ are slightly, tinged blue by iodine, the protoplasm and spores acquire a deep shade of yellow. Hence a section of the hymenium, to which iodine has been added, is, under the microscope, perhaps even a more beautiful object than a section of the same hymenium in its natural state. The thecæ, in the majority of cases, disappear after rupture and escape of their contents. But, in some cases, the spores become shrivelled and aborted, and then carry with them the thecæ as caudate appendages or tails. Sometimes, but rarely, the thecæ present bulgings opposite individual spores, as if the walls were very thin and easily distended by unusually large spores. Such bulgings may occur opposite every spore, or only opposite one or two in a theca; and such thecæ have more or less of a moniliform character. The thecæ appear to be developed with amazing rapidity, young ones shooting upwards from the hypothecium as old ones become ruptured and decay. May we not accept this fecundity of the hypothecium, this great number of thecæ, and consequently of spores, as a beautiful instance of design in an alpine species, to obviate the counteracting influences of extreme cold and atmospheric vicissitudes?

The *paraphyses*, I have already stated, are about equal in length to the thecæ, but they appear to vary somewhat in size. Hence one great reason, probably, of the fact that the apices of the paraphyses *en masse* are not so smooth or even as in the majority of lichens, but are irregular, appearing here and there between or above the apices of the thecæ. They also appear to be fewer in number, compared with the number of the thecæ, than in most lichens; they are collected in bundles, which are sparingly scattered between the groups of thecæ, and by which they look as if compressed. The apices are knobbed; that is, they terminate in irregular wart- or knob-like cells of a deep indigo-blue colour. This colour of the terminal cellules, or articulations of the paraphyses, is the cause or source of the deep tint of the upper surface of the hymenium. The filaments of the paraphyses are delicate and wavy, and form a somewhat lax network *en masse*.

The *spores* are about $\frac{1}{2300}$ inch in diameter. They are regularly globose, having a globular pale yellow nucleus, between which and the cell-wall there is an interspace forming a hyaline distinct margin. Körber says the spore altogether is hyaline and colourless: this I cannot corroborate. The nucleus

and protoplasm have always appeared to me pale yellow. In the young state the spore is full of a finely granular or grumous protoplasm. The granules increase in size, and become aggregated into a distinctly circumscribed, globular, homogeneous nucleus, which leaves a hyaline margin, as above described, between itself and the spore-wall. In the old state of the spore the nucleus again resolves itself into a mass of granules and globules, filling the whole cavity of the spore, which may also lose its regularly globose form. The spores are generally in apposition and ranged, one immediately above the other, in linear series in each theca. Until they approach maturity, they are, as has been already mentioned, glued together, though not very tenaciously. Sometimes a smaller number than usual (eight) are developed at intervals in the thecal protoplasm, which appears as a ribbon-shaped mass stringing together the spores like so many beads. The spores never become coated with an indigo powder, or with dark granular débris, as in Sphærophoron, but remain smooth and pale yellow throughout. They bear a certain resemblance, however, to the spores of *Sphærophoron coralloides*, Pers. (Tulasne, Mém., pl. xv, figs. 4 and 8) and of *Calicium turbinatum*, Pers. (Tulasne, Mém., pl. xv, fig. 15); but the bluish-black epispore distinguishes those of the former, and the brown colour those of the latter, while in both the spores are much smaller.

The *spermogones* are visible, under a good lens, as minute, punctiform warts,—black to the naked eye, but deep brown under the microscope. They are sparingly scattered on the surface of the thallus in the neighbourhood of the apothecia, or more frequently on sterile squamules, there being seldom more than two or three on a single squamule, placed at a little distance apart. These warts are found, on examination, to be papillæ pierced by a pore, which is frequently invisible even with the aid of a good lens. This pore is generally simple and round, but it may be finely stellate. It leads into and forms the external opening of the cavity of the spermogone, the body of which is wholly plunged in the substance of the thallus. The spermogone is of a somewhat spherical form; its cavity is simple, and its envelope thickish, and formed of roundish or irregular, small, deep brown cellules, closely aggregated. It is surrounded by the thickish, white, medullary tissue of the thallus, in which it is originally developed as a small nucleiform, brownish mass. The ostiole or pore, instead of opening in a papilla, sometimes, in the old state, is surrounded by a slight depression of the thallus.

The *sterigmata* are about $\frac{1}{1000}$ inch long, but they vary

greatly in length. They consist of very fine, sublinear cells, simple, or composed of two or three cylindrical cellules; they are generally kneed, or present irregular bulgings and bendings. They are not unlike the sterigmata of Abrothallus (Monograph of the genus Abrothallus, 'Journal of Microsc. Science,' Jan., 1857, p. 60, and Pl. V, figs. 1 and 2). They usually taper gradually into the spermatia, which are given off as buds from their apices. I could sometimes trace the sterigmata given off in groups of three or five, like fingers or digitate processes, laterally from irregular, ramose, articulated, thickish tubes, imbedded in or springing from the internal walls of the spermogone. The sterigmata are very closely appressed, and *en masse*, under a low power, they appear as mere striæ arranged convergently to the cavity of the spermogone.

The *spermatia* are about $\frac{1}{3000}$ to $\frac{1}{2500}$ inch long. They are straight, rod-shaped, hyaline bodies, with obtuse ends; having, indeed, the characters of the spermatia of the majority of lichens. In some spermogones I did not observe the spermatia floating free; they were attached to the sterigmata. But in such cases they appeared about double the size of those I found in myriads floating free in other spermogones. Tulasne, I think, has noticed a similar phenomenon in the spermogones of certain lichens; and he hazards the opinion, for the fact is by no means established, that such large spermatia, after being thrown off, divide fissiparously into two. In some spermogones, where the spermatia were extremely numerous, they were also so minute that they could with difficulty be distinctly seen (under power 380). (Pl. XI, figs. 1—16.

On Self-division *in* Noctiluca.

By Thomas Brightwell, F.L.S.

The observations we have to communicate on the subject of Noctiluca may properly have for their text or starting-point the following passages in vol. iii of this journal:

Dr. Busch, at p. 201, says—"In Pl. X, fig. 7, is represented an animal apparently referable to Noctiluca, and which might readily be imagined to represent a gemmule fully developed on a perfect Noctiluca, which had pullulated on the disc itself, and only required to be detached to become an independent individual. But the author is rather inclined to believe that it is only an abnormity, a double monster; for, if a germination of this kind really took place in this class of animals, it would be very remarkable that only a

single instance of it should be presented among the innumerable multitudes of individuals brought under the author's observation."

Mr. Huxley says, at p. 54—"Quatrefages and Krohn consider that a process of fissiparous multiplication takes place in Noctilucæ; both of these observers having found double individuals, though very rarely. According to the latter writer, division of the body is preceded by that of the *nucleus*. I have not had the good fortune to meet with any of these forms, and the only indication of a possible reproductive apparatus which I have seen, consisted of a number of granular, vesicular bodies of about $\frac{1}{2000}$th inch in diameter, scattered over the surface of the anterior and inferior part of the body."

Dr. Webb, p. 105, remarks—"The mode of reproduction is at present far from being satisfactorily made out. I have never met with a double individual, but on one occasion witnessed the process of division, without, however, noting any proof of its connection with that of fissiparous multiplication."

The facts we have to adduce tend to show that the conclusion of Quatrefages and Krohn, "that a process of fissiparous division takes place in Noctiluca," is correct; but further investigation of the subject is called for, and though we trust these facts will be deemed of sufficient importance to deserve record, we would urge those who have opportunity to follow up the investigation of the subject. Lieutenant-Colonel Baddeley (now residing at Gorlestone, near Yarmouth) has devoted much time and attention to the investigation of a Noctiluca, and it is to his observations and drawings I am almost entirely indebted for the material of this communication.

The Colonel's observations commenced in October, 1856, when the animals were plentiful, and have been continued to the present time (June, 1857), the animals not entirely disappearing in the winter months. Several of the drawings are made from specimens taken in the month of December last; a season when these delicate little creatures would hardly have been looked for on our shores.

We have seen that other observers speak of double forms as of rare occurrence, as abnormities, and double monsters, and mere adhesions. Colonel Baddeley has met with double forms in considerable numbers. I have figures of twenty specimens of double forms, carefully drawn by him from living specimens, each figure being from two to four inches in diameter; and he states that he has never made a gather-

ing of the Noctilucæ without detecting double forms among them, and in some they were abundant.

A general idea of the process of division will best be obtained by the figures we have given, showing the commencement and gradual formation of a double form, and the ultimate disruption into two separate individuals. See Pl. xii, figs. 5, 6, 7, 8, 9.

Colonel Baddeley's observations lead him to infer that this process begins by the gradual formation of a second *nucleus*, which, after its commencement, rapidly arrives at the size and appearance of the other. A second globular substance, also, (termed, by some previous writers on the subject, the *mouth*), is formed in addition and near to the nucleus, and a constriction, small at first, but gradually increasing, takes place, until the perfect Noctilucæ are developed, united at last by a thin band, which is speedily ruptured.

The whole process seems to be accomplished in a few days. In a gathering made the 7th of March last, numerous double specimens were observed. On the 13th of the same month, only two double specimens could be found, held together by a slight band; and from that time to the 27th no double specimens could be detected.*

It will be seen that Krohn, (admitted by Mr. Huxley to be a most excellent and accurate observer) states that *the division of the body is preceded by that of the nucleus;* and it is a strong confirmation of this statement, that Colonel Baddeley, from his own observations only, should have come to the same conclusion.

Colonel Baddeley's remarks on the general structure of these animals, the nucleus, mouth, tooth, cilium, and gastric pouches, agree with those of previous observers as detailed in Mr. Huxley's excellent paper, and they need not be repeated here. Colonel Baddeley observes that scarcely any two individuals are exactly alike, some having the vacuoles and small oil-like globules distributed through their substance, while others have nothing of the kind. He has seen portions of the oil-like globules mixed with fluid pass out below the oral opening, as if through an anal one. Many individuals are also found destitute of the remarkable organ called the tail.

The observations of Dr. Busch (see vol. iii, 'Micr. Journ.,' p. 203), and particularly those of Mr. Gosse (see his 'Rambles on the Devonshire Coast,' p. 257), clearly demonstrate that the Noctilucæ increase also by germs or gemmæ.

Colonel Baddeley's observations have not led to the detec-

* Colonel Baddeley has since satisfied himself that the whole process of division does not occupy more than twelve hours.

tion of any process of this kind; but in many individuals he has observed "the yellow, clear globules, with a central, well-defined nucleus, more or less developed, of a rich reddish hue;" described by the above authors, and deemed, if not proved, by the latter, to be germs of Noctilucæ. (See Gosse, pl. xvi, fig. 10.)

When irritated, the Noctilucæ give out a phosphorescent light, which under a high magnifying power presents points of light more intense than the general glow. In captivity they soon lose this power.

Little has hitherto been said as to the food of the Noctilucæ, and it will, we think, surprise some of our readers, to find that these animals, small as they are, are sustained by Diatomaceæ, and that, in these microphagists, we have the means of supplying our cabinets with specimens of some of our rarer diatoms.

Colonel Baddeley observes that he finds, when newly gathered, each Noctiluca has several diatoms in its interior, lying in the various chambers or gastric pouches distributed throughout the body of the animal. These diatoms all disappear in a few days, leaving nothing visible but the vacuoles, or alimentary sacs, filled with granular particles. A very careful pressure shows an orifice, near the tail of the animal, the opening of which may be detected by careful pressing, and from this is protruded, by continuous gentle pressure, a very thin hyaline sac, filling gradually with fluid and small globular particles, till it attains about one third the size of the animal, when it bursts and disappears. On a greater pressure being applied, the so-called mouth, together with the thread-like walls (the network of fibres and fibrils of Mr. Huxley), shoot out through the opening, and float away.

In a paper published by Mr. Huxley in the 'Annals Nat. Hist.' (vol. viii, new series, p. 433), on *Thalassicolla*, he states that its structure is essentially similar to that of *Noctiluca*, and that there is a perfect analogy between the structure of his *Thalassicolla nucleata* and *Actinophrys Sol*. He defines the latter, "a spherical gelatinous mass, consisting of an internal dark granular portion, and a clearer external zone, from which many radiating threads are given off. Vacuolæ are scattered through the substance, larger in the external zone, smaller and more irregular in the interior. If the animal is much compressed nuclei and nucleated cells are forced out from its interior." Mr. Huxley, in this paper, intimates his opinion that, in the case of *Actinophrys sol* and *Noctilucæ*, no spontaneous fission takes place, but that two individuals may fuse together and become one.

In 1848, I stated, from my own observations, that *Act. Sol*

multiplied by self-division, two and sometimes three individuals adhering by the outer edge only. (See 'Fauna Infusoria,' p. 21.) Eichhorn is also stated to have seen self-division in *A. Sol;* and the question may, we think, be considered as put to rest by Mr. Weston, who has, from his own repeated observations, written down self-division in *A. Sol as a fact.* (See 'Micr. Journ.,' vol. iv, p. 120.)

The facts now brought to light relative to the Noctilucæ, tend, we apprehend, to show that they must take their place in the lower rank of organized beings, and that they have some affinity with *Actinophrys Sol,* though by no means congeners with it.

Before completing the plate illustrating this article, Mr. Tuffen West went down to Gorlestone to make some additional drawings from living specimens, and he has also furnished me with some notes, the result of his observations, which I have great pleasure in adding to this paper.

"Slight movements of the Noctilucæ cause them to vary so much in their apparent form, that it is difficult to obtain an exact idea of their true figure. By turning the live box in which specimens are contained upside down occasionally, and watching them as in their progress to the surface they roll over and over, a good idea of these changes of appearance may be obtained. A pyriform or balloon shape is thus frequently seen, at the smaller end of which is the fissure described by previous observers, and near to it the mouth with the root of the tail, &c. We term this '*the side-view*' (see fig. 2). The so-called 'tooth,' or rather '*prehensile organ,*' in some cases presents exactly the appearance figured by Mr. Webb; in others that given by Mr. Huxley ('Micr. Journ.,' vol. iii, Pl. V, fig. 34 *d*). It appears to be formed by a duplicature of the general integument, from which it differs little in density or appearance. I did not see it in independent motion, but repeatedly moved in connection with the movements of the tail.

"The 'cilium' once seen can hardly fail to be again instantly detected; its action is intermittent; periods of rest of a second or two being followed by rapid undulatory movements for eight or ten seconds. Its motion is probably subservient to respiration, and is to be classed with the 'trembling organs' so lucidly described by Professor Huxley in *Lacinularia* ('Trans. Micr. Soc.,' vol. i, n. s., p. 7), and subsequently in *Echinococcus.* The sarcode fibrils constantly, though slowly, change their form and position. I once saw two processes move rapidly out from near the nucleus,

precisely like those of an Amæba; these were shortly afterwards withdrawn. The granules with which the fibrils are studded glide gently up and down the threads. The vacuoles may also be seen to change their form and position under the eye of the observer, and sometimes they entirely disappear in individuals that have fasted for some days Pl. XII, fig. 6). They appear to be temporary sacs or stomachs, formed in the sarcode mass as they are required for the reception of food, and ceasing to exist as such after the food is digested. The number and size of the vacuoles communicate a greater or less degree of buoyancy, and so enable the animal to rise or sink. The mouth of the Noctiluca is probably a mere slit. The form given in fig. 15 may perhaps be the œsophagus. The 'pinching off' a portion of the body of a Noctiluca, described by Dr. Webb, has been repeatedly seen by Colonel Baddeley, who showed me one example of it (fig. 10); it may, perhaps, be an abortive attempt at self-division, failing from the absence of a *nucleus*.

"The existence of striped muscular fibre in the Polyzoa, when first asserted by Mr. Busk, was received with much hesitation, though it is now an established fact. The tail of the Noctiluca appears also to me to contain *striped muscular fibre*. Late researches go far to prove that (whatever may be the true explanation of the appearance called striation) its presence has much to do with the power and rapidity of muscular action. The powerful motion of the tail in a Noctiluca is very remarkable in so small a creature."

An examination of the Diatomaceæ found in the Noctilucæ has brought to light facts of not less interest than those arising from an examination of the animals themselves.

Professor Smith (in vol. i of his 'Brit. Diat.') has described and figured (see 'B. D.,' p. 27, and pl. v, fig. 46) what he, at first, called *Triceratium striolatum*, and corrected to *T. undulatum* of Ehr. There appears a pseudo-nodule in the centre of the figure given of this species, but Professor Smith, in his observations on the genus, p. 26, observes—"The appearance of this pseudo-nodule is probably accidental in the single individual from which the figure was drawn."

I had never seen a recent specimen of *T. undulatum* till Colonel Baddeley's examination of the Noctilucæ brought many under observation. Those prepared in acid showed the pseudo-nodule as in Professor Smith's figure, but a careful examination of the material, subjected only to repeated washings in soft water, brought to light these Triceratia in a connected state, and has shown that the so-called pseudo-nodule was

only the stump of a long cylindrical horn, standing straight out from the centre of the triangular end of the frustule. The edges of the end are fringed with a comb-like row of papillæ or setæ. In the same state of the gathering were also seen individuals having the end view in the form given by Professor Smith.

Triceratium striolatum, Roper, *T. alternans*, and *T. variable* were found in the same material, but the species which seems to constitute the principal food of the Noctilucæ is the *Actinocyclus undulatus*, Kutz. It has been found in very great numbers in every gathering, and it appears to constitute a large proportion of the diatomaceous contents of the Noctilucæ.

Living specimens of another form, which we deem to belong to the genus *Rhizosolenia* of Ehr., were detected in the Noctilucæ, and we have also received from Mr. Norton, of Hull, specimens of the same, or a nearly allied species, found in an Ascidian, in which Mr. Norton was fortunate enough to detect many specimens in a perfect state.

This species consists of a long transparent tube, having a delicate twisted or spiral appearance, running through its whole length, as in some of the fresh-water Algæ, and at either extremity a styliform testule, with bifid branches inserted in the tube. The entire forms, when subjected to acid, break up, and leave the siliceous Rhizosolenian frustules perfect; but fragments only of the tube are found, in the shape of imperfect rings. We propose, under the above definition, to give this species the name of *R. styliformis*.

We hope to be able to give further details of the remarkable forms of Diatomaceæ found in the Noctilucæ in a future number of this journal.

On the Microscopical Characters *of certain so-called* Cetacean Bones *associated with* Cetolites, *in the* Detrital Bed *of the* Red Crag *at* Felixstow, Suffolk. By the Rev. J. B. P. Dennis, F.G.S.

In the detrital bed at the base of the Red Crag, especially at Felixstow, in the county of Suffolk, are found very singular fossils, and in such considerable quantities that they have been made available for economic purposes. But while the manufacturer of artificial manure is daily grinding down heaps of the relics of a former world to renovate the earth,

in accordance with that law by which Nature, phœnix-like, arises with renewed beauty out of her own ashes, surely it would be ill becoming the scientific age we live in, not to derive at the same time intellectual advantage from these remarkable remains; and this has, in some measure, already been done—for amongst the fossilized fragments some were observed to be of regular form, and, though water-worn, still gave indications of their origin, and the credit is due to the Rev. Professor Henslow for the discovery of the tympanic bones of whales of which Professor Owen has determined several species. I am not aware, however, that any attempt has been made satisfactorily to determine by the aid of the microscope the nature of other associated bones which, from their irregular shapes, afforded no sure indications of the animals to which they once belonged, and I think it has been too prematurely concluded that they all belonged to huge whales, which have so plentifully left their ear-bones in the Crag; the microscope, and that alone, if judgment be employed in its use, must eventually settle this question. These irregular portions of bones evidently belonged to massive animals, and our study must be directed to other bones of such animals for a solution of the problem before us; and it would be certainly jumping too soon at a conclusion to assign all the rolled bones found in the Red Crag to cetacean origin, because the hard tympanic bones of many whales have escaped the wreck of ages, and still remain as monuments of those huge creatures that once sported in primæval seas. In fact, a slight examination of those osseous stones that have been rolled like the flints and other portions of rocks that form the present shingle on our coasts, must lead us to suspect the existence formerly of mighty mammifers which probably once trod on dry land and roamed over extensive regions; and who shall estimate the centuries during which those bones have rolled to and fro on some primæval beach, lashed by the surge of seas which have, like those ponderous animals, been swallowed up by all-devouring time. We may fancy their first entombment, when probably numbers fell a sacrifice to some geological vicissitude during the convulsions of Nature in her throes to give birth to the world we live in, while she travailed with child—the future parent of civilisation and of the arts and sciences. Then again we see the deposit in which they were inclosed—"the great mammoth burial-ground"—broken up, becoming the sport of ocean, the bones torn from their resting-place and dashed to fragments on the shore, the harder portions resisting the action of the waves, and fighting for the mastery inch by inch, until the

waters, vanquished at last, have spent their fury, perhaps shutting themselves out by their own turbulence, or else the land has risen in its defence. Thus again the osseous fragments are found entombed—the diminished, but not totally destroyed, remains of noble forms. Ages again roll on, and the Red Crag protects them, but not for ever,—the sea returns to the attack, and man, more ruthless than the waves, seizes upon them, and carries them away from their resting-place to grind them fine as the dust, and scatter them over the fields, not like the sown dragons' teeth, to raise a crop of mail-clad warriors, but that they may reappear in the staff of life, and so fill the fields with joy and gladden the heart of man. To descend, however, from the regions of fancy, if a reality in some measure has not been fancied, let us engage ourselves with the facts before us.

I have before my view some of these queer-shaped fossils, as hard as stones, shining as if the waves had licked their surfaces for countless ages; yet still, in their roughly chiselled outlines, may be traced the characters of bone, the abraded cancellous texture in parts is visible, and if you break one with a hammer, the grain, so to speak, of bone, and that of some once powerful animal, becomes apparent, the eye at once assures you that these stones were bones ages ago, endowed with life and motion; and if a step further is gone, and a chip, shivered off by the stroke of the hammer, is placed upon a glass slide, and warmed with a little marine glue over a lamp, and then, when it is cool, ground to a fine section, the microscope will reveal the marvellous structure of bone; then will be seen Haversian tubes and numerous lacunæ, and very often with their canaliculi in perfection, and so they plainly speak to you, if you can interpret their characters, what their former life was, and to what animals they belonged; for no Assyrian cuneiform inscription, no Egyptian hieroglyphic, ever told a plainer story to the skilful interpreter than these bones will tell to him who takes the trouble to look into their legible characters; nor do I deem the inquiry a trifling one, for, indeed, it is a matter of deep interest to the geologist and naturalist to restore lost forms of life—and this is rendered practicable by the patient examination of fossil and recent bone. If a section of fossil or recent bone of any known and large Pachyderm is examined under the microscope, two very distinct kinds of lacunæ, each with characteristic canaliculi, are apparent—the one sort fusiform, with numerous fine and nearly straight canaliculi; the other oval or roundish, with thicker-stemmed, less numerous, and branched canaliculi. Nor are the fusiform intermixed with the others, but

form separately bands or stripes parallel with the Haversian tubes, or surrounding them, as the section may happen to be made. Between these bands appear the other distinct and characteristic lacunæ, which for the sake of distinction I shall term free lacunæ, as the others, for the same reason, may be called Haversian lacunæ. These distinctions are not any peculiarity in the bones of Pachyderms, and are equally shown in those of Cetaceans. In an inquiry, then, of this sort, we have to consider, amidst a general resemblance, the nice and real points of difference. In the comparison of mammalian bone, the question is more one of degree than anything else; Cetaceans present a *coarser character of bone* than Pachyderms. At an early period of my investigations I was somewhat misled by engravings of whale's bone, from which I thought that the canaliculi of its bone were numerous and fine; actual observation teaches me that such is not the case. The canaliculi in all cetacean bone are, for mammalian bone, coarse, and easily distinguishable from those of the elephant, &c. I have now examined both the Greenland whale, sperm whale, dugong, manatee, dolphin, porpoise, walrus, and seal, and find this *characteristic of all*—the dolphin and seal approaching the nearest in respect of fineness to the elephant; for even the ivory-like rib-bone of the dugong exhibits canaliculi visibly coarse in comparison with those seen in Pachyderms.

In cetacean bone, especially in the Greenland whale, sperm whale, and porpoise, as also in others in a less degree, the canaliculi of the free lacunæ very often branch out in a long and straggling manner, as shown at Pl. XIII, fig. 10; and this appears to be a distinctive characteristic of the whale's bone, and more so in the Greenland than the sperm whale; it is also well seen in the porpoise, &c. The bones of both the elephant and whale which have been obtained from the Drift are generally very perfect as to their microscopical characters. In the fossil whale, the free lacunæ having coarse, few, and straggling canaliculi, give a very clear and distinctive character to its bone, while the greater number and greater fineness of them in the elephant sufficiently distinguish the bone of that animal from the whale. The greater general regularity of the free lacunæ in Pachyderms, both as regards form and direction, affords another test. The canaliculi of the Haversian lacunæ of both the Greenland and sperm-whales often run into one another, or dilate in portions of their course, especially at the ends, which is a marked distinction from the fine and delicate characters of those of the elephant. The Haversian tubes, when they are better understood, will also

furnish other clear distinctions; but it is, perhaps, too premature, at present, to found any arguments upon them; yet in the case of figs. 1 and 6, it may be seen, especially in the latter, that there is no correspondence with the whale. Fig. 1 is taken from a flat fragment of bone which, if it belonged to the whale, must have been a rib. It differs from that of the whale's rib as well in its fine and close-grained structure, as in the character of its Haversian tubes. The whale's rib appears to be made up of cancellous structure, while in the rib of the sperm-whale the Haversian tubes expand into the same sort of cavities, but I can detect very little difference otherwise; perhaps the canaliculi in the sperm whale are a trifle finer and more numerous than those of the Greenland whale. Fig. 1 represents a section of rolled Crag bone just adverted to; and fig. 2, fossil elephant from the Drift; and on the right, figs. 8 and 9, the jaw of the whale, recent, and the vertebra of the same, fossil: they are accurately engraved, so as to show the relative thickness and number of the canaliculi. Fig. 1, in its Haversian lacunæ, shows the delicacy and distinctness characteristic of Pachyderms; and the free lacunæ compare in all essentials likewise. The marvellous distinctness often exhibited in the fossil bone of the Drift elephant I have not met with in any Crag specimen; the canaliculi more or less are obliterated, but in those parts of the section where they are less so the correspondence is visible. Fig. 3 gives, more highly magnified, the free lacunæ of a Crag fossil and Drift elephant, taken from different specimens, but exhibiting the same characters; and, in fig. 4, are seen the Haversian lacunæ of Crag and Drift fossils compared together; and on the opposite side of the plate (figs. 10 and 11) are shown the lacunæ, free and Haversian, of the recent and fossil whale, magnified in a similar degree; by which the relative coarseness and numerical proportion of the canaliculi may be judged of, as well as their blurred appearance and their thickening at the ends, so very apparent both in the Greenland and sperm whales. In figs. 3 *a*, 4 *a*, representing lacunæ of the Crag fossils, it will be seen that as much as they approach those of the fossil and recent elephant (figs. 3 *b*, 4 *b*, and 12 *a* and *b*), so in an equal degree do they differ from those of the whale (figs. 10 and 11). I cannot distinguish any difference in size between the canaliculi of fig. 4 *a* and fig. 4 *b*, though, from the more perfect condition of fig. 4 *b*, they appear more numerous. They appear finer and more numerous than those of fig. 14 *a*, which is elephant from the Gravel, as also they compared well with those of the recent elephant. Not having yet been able to procure the bone of

the mastodon, I am ignorant at present of its correspondence with the elephant in this respect.

The very general similarity of cetacean bone is a great help in the matter, and nothing can be more striking than the comparison of recent with fossil bone. Their agreement is shown in figs. 8, 9, 10, 11, with which the other figures of Crag and elephant bone, &c., bear no likeness. There seems, then, to me to be fair evidence, as shown by microscopical comparison, that the bones of Pachyderms, or at least of land animals perhaps of more massive proportions, are discoverable in the rolled Red Crag fossils. But perhaps a step even further may be gained. Fig. 12 represents the lacunæ of the elephant; fig. 5 *a* those of the hippopotamus; and fig. 5 *b* those of the rhinoceros; by which it may be seen that the free lacunæ in each of these animals differ—those of the rhinoceros being more distinct and somewhat smaller than the elephant's, and those of the hippopotamus being larger; and from noticing these distinctions, I have been led to suspect that in the rolled bones of the Crag several different genera are represented. Fig. 13 very much compares with the bone of the hippopotamus by the intermixture of sets of larger lacunæ, as also by the twisted characters of the Haversian bands; unfortunately the canaliculi are destroyed. Fig. 6, in its more perfect lacunæ, agrees, perhaps, with the rhinoceros; it has nothing whatever cetacean in its character. The Haversian tubes, in fig. 6, indicate a land animal, and one that moved with some speed over the ground, and such a disposition I have not yet found in any cetacean bone. Taking fig. 6, both as regards the Haversian tubes, lacunæ, and canaliculi, it affords a most instructive instance of the existence of a land animal, of which we can obtain no further information than that which a small portion of its bone supplies us with; that information, however, is important; and we only wait for further knowledge concerning the disposition of the Haversian tubes to enable us, as it were, to replace the fragment in its proper position in the skeleton. At fig. 7 is a comparison of another Crag fossil with fossil elephant from the Himalayan mountains; fig. 7 *a* represents the ordinary characters of very many of the Crag rolled bones; fig. 7 *b* giving a portion of the vertebra of the fossil Himalayan elephant. Neither specimens of bones are very perfect in details, but are very similar in general characters, and appear to have experienced, before they became fossilized, a very similar partial decay. Fig. 14 *a* represents elephant bone from the Suffolk Gravel, much decomposed and hardly fossilized. This compares well with the recent elephant, and better with fig. 1 than with fig. 2;

but it is very probable that the different circumstances attending the fossilization of bones from different formations may have the effect of giving a somewhat different appearance to them, and which must be taken into account in deciding upon them. To show the extent to which even recent bone may be decomposed, if only exposed for some time to atmospheric agency, I have introduced, at fig. 16 *b*, a section of the spinous process of the vertebra of a porpoise picked up off the shore at Felixstow. In outward appearance the vertebra was unaltered, but the continued action of the elements has obliterated all internal *microscopical* organization in the bone. You may search in vain for lacunæ, canaliculi, or Haversian tubes. This same destruction of microscopical structure, more or less, I have observed in bones that have been buried in soil for a length of time, as grave-yard bones, or have been otherwise exposed to the action of decay; and it is not enough in inquiries of this sort to acquaint ourselves with the characters of recent or perfect bone, but we ought also to know the different appearances or stages of decomposed bone, and for this purpose I have examined half-decayed bone, such as may lie tossing about in the soil of a garden, or have been buried in loose material. However decomposed bone may be when even the Haversian tubes are obliterated, yet here and there possibly may be found a stray lacuna with pretty perfect canaliculi; and so distinctive appear to be the great classes in this respect, that one perfect lacuna, with its canaliculi, is enough to decide the class of vertebrata to which the bone belongs. But I fancy had I brought forward any fossil bone as much decomposed as the recent bone is that I have figured at fig. 14 *b*, and attempted to prove even in its decomposed state that it might have been mammalian, no one would have believed me. And this should teach us what great caution is required before we reject as not mammalian any fossil bone which has been more or less exposed to those destroying influences that appear to date the beginning of their operation even in primæval times. And it is a matter of great wonder that, in spite of these sinister influences, so much of their true characters are yet retained in bones that have fallen under their sway for ages; and we can only account for it by the presence of an antagonistic principle by which organic substances are changed to fossils, and thus decay becomes arrested when once the magic wand of petrifaction has touched their particles, which before were ready to take wing and fly away.

To sum up:—A very patient comparison of cetacean and pachydermal bone, both recent and fossil, with the Red Crag

fossils, such as are shown in the plate, having established in my mind the leading distinctions that appear to exist between the elephant and the whale as respects the microscopical characters of their bone, though I cannot positively identify the Crag fossils with either the recent or fossil elephant, yet their much greater analogy with the elephant than with the whale, their agreement in all essential particulars with the pachydermal type,—(as indicated by the greater fineness and number of the canaliculi, by the greater uniformity of the lacunæ, and also, with great probability, by the characters of the Haversian tubes)—induce me to conclude that the animals to which such bones once belonged were not truly aquatic in their habits, but were land animals, or, if at all aquatic, that they had the means of terrestrial progression such as are enjoyed by large Pachyderms. The considerable thickness of the cortical portion of the bone in these Crag fossils appears also to afford another argument against their cetacean origin, for the apparently massive jaws of the whale have only a thin coating of cortical substance enclosing the cancellous structure. I do not know why we should disbelieve the evidence I have adduced of the existence of these Pachyderms, when portions of the teeth of the mastodon have been obtained from the Red Crag, of which there is a rolled fragment in the Museum of Bury St. Edmunds. If the rolled bones which I have examined are cetacean, they are microscopically distinct from all known Cetaceans which I have had the means of examining; but supposing I am mistaken, still the subject is of sufficient interest to justify an inquiry, nor am I aware that the attempt has been made before, either to draw a comparison between the microscopical characters of the bone of Cetaceans and Pachyderms, or to figure any of the rolled bones of the Suffolk Crag.

But the question arises, where and when did these animals live? Fresh disclosures are now daily coming to light in reference to the ancient mammalia of the earth. To say nothing of the Microlestes of the Trias of Wirtemberg, or of the rib-bone from the Lyme Regis bone-bed, and which the inimitable engraving of Mr. Tuffen West, as given in the 16th number of this journal, shows could have belonged to no other animal than a mammifer, nor to mention the four Stonesfield mammalian jaws,* one of which, the *Stereognathus ooliticus*, I discovered myself, we have now the announcement from Sir Charles Lyell, in his Supplement to

* That is, of four distinct animals, viz., *Amphitherium Prevostii*, *A. Broderipii*, *Pharcolotherium Buckklandi*, and my *Stereognathus Ooliticus*.

the fifth edition of his 'Manual of Elementary Geology,' of the discovery by Mr. Beckles, in the Middle Purbeck Oolite, of about fourteen different mammifers; and it is worthy of notice that all these animals were of small size, the largest not exceeding a rabbit. Are we to suppose that no large mammifers were cotemporary with these living creatures, and may it not *be just possible, that in the Red Crag of Suffolk, exist the mammalian relics of cotemporaries of* Stereognathus, *of* Spalacotherium, *and* Plagiaulax. The giving utterance to such an idea may, in the eyes of some, convict me of geological heresy; but if we look a little into the facts of the case, it will perhaps not appear so imaginary as at first sight. The first question to consider is, did they belong to the Red Crag or Pliocene period? or, in other words, were the animals living about the time of that formation? If so, supposing that inundations and rivers conveyed these once ponderous bones to the sea, and the sea then rolled them, they must have become fossilized after they were deposited in the Red Crag; but, on the contrary, they show evidence of having been fossilized anterior to their having been rolled—they have still the gloss upon them that they acquired when they formed the shingle on the beach. They were *veritable stones then;* if they had not been so, all trace of the structure of bone would have been obliterated, whereas this structure is often marvellously preserved. There must then have existed some deposit that once contained the fossils in a more perfect condition, and where they *became petrifactions;* the older Tertiary beds in this country, with the exception of a cetolite and several cetacean fragments found in the London Clay, affording no clue as to their primary sepulture; and supposing them to be the spoils of Eocene deposits, we have a right to expect to find them there in greater numbers and perfection. I cannot think, then, that the deposit to which they primarily belonged is anywhere developed in this country; and they might have lived, for aught we know to the contrary, when Oolitic forest trees grew in Portland, and have trodden down beneath their feet tropical cycadites. If a rolled flint is picked up, though time has altered its outward appearance, there is no difficulty in determining whence it came, though we may not be able to follow it through all the journeys it has made since it became a hard substance; and so the mineral characters of the Crag fossils seem to afford the best, perhaps the only clue to the time when they formed parts of living beings, and these characters appear to agree with those of fossilized bone belonging

to a period anterior to the Tertiary strata of this country. Surely, if the bones of the iguanodon had found their way from the Wealden to the Red Crag, and had been rolled and tossed about *in transitu*, they would have presented to the eye very similar mineral characters; in fact, I have a small portion of rolled bone in Oolite, having the same gloss and fracture; but as this is not a microscopical question, I need not pursue it any further.

If the assumption of Sir Charles Lyell is worthy, as it seems to be, of our consideration, and that, to quote his striking language, "we may now with more confidence assume that the sea of the Coralline Crag was open to the south, so that shells of southern forms lived in it, until at length the bed of the sea having been upraised 650 or 700 feet, all communication with warmer latitudes was cut off, and the fauna of the Red Crag acquired its more boreal characters;" then, upon this hypothesis of a sea open to the north, and by the destruction of strata as well, fragments of fossil bone would have got into the Crag sea, as Drift fossils now are continually doing on the Norfolk coast, and were rolled along the beach perhaps for ages, and during which they might have travelled considerable distances. How little should we have known of the animals whose bones have been found in Kirkdale Cave, if Hyænas had not resorted there. So in reference to the rolled bones of the Red Crag, the accidental circumstance of their having been treasured up therein as relics of the ravenous sea, has given us a knowledge of them which otherwise we could not have obtained, whether they belonged to the Tertiary or Secondary epoch.

On "Finders" *for* Microscopes.

By Arthur M. Edwards, of New York, U.S.A.

The importance of having an instrument, simple, and at the same time accurate, for the purpose of registering objects mounted on microscope-slides, so that they can easily and with certainty be again found, has occupied the minds of microscopists at different times; and several pieces of apparatus, more or less complicated, have been the result.

Perhaps the best of these is that invented by the late Professor J. W. Bailey, whose recent loss cannot be felt more

by his countrymen, than it will be by the lovers of science in Europe.*

In the report of the committee of the Microscopical Society, appointed to consider the subject of an efficient *finder* for the microscope, the following properties were considered essential:—"*First.* It should be applicable to any microscope, whether furnished with stage movements or not; and it should not preclude the use of those movements. *Second.* It should not require new labels to be placed on the slides, or any mark or index to be made upon them. *Third.* It should not be necessary to remove the slide or finder for the registering or finding of every separate object. *Fourth.* The divisions on the index should be easily read. *Fifth.* It should allow the microscope to be used in the inclined position; and—*Sixth.* It should be cheap, and simple enough to be constructed by any one possessing a moderate amount of mechanical skill."

The first of two instruments which I am about to describe fulfils all of these requirements, if we except, perhaps, that one which says it should be so simple that it might be made by the microscopist himself. It is true that mine could really be so made; but when we wish for exactness in graduation in an instrument of this kind, it is best to have it so graduated by a proper workman; and I have had mine engraved, so that I might have as many impressions as I should need, all alike in the essential point of correct graduation.

As the slides mostly in use are those of the dimensions recommended by the Microscopical Society (of three inches by one), I have had my indicator made to that size; though, of course, as will be seen from the description, it could be of any dimensions.

Before describing the indicator itself, I shall speak of the preparation of the microscope necessary for its use.

The stage is ruled with two lines across it, intersecting each other exactly in the centre of the field of vision; and in the case of those microscopes having mechanical stages, these lines are continued across a circular piece of glass, which is made to fit into the hole in the stage, and the point where they cut each other is always brought into the centre

* Professor Bailey has bequeathed to the Boston (U.S.) Society of Natural History his whole microscopical collection, contained in books, with an index-volume, his collection of Algæ, his rough material for microscope research, including his cabinet of minute fossil animal and vegetable forms together with his microscopic memoranda and unpublished papers, and his very valuable library of microscopic and botanical works.

of the fie'd by the stage movements when the indicator is about to be used. This ruling of the stage and circular piece of glass can, however, be done away with, by using a card of the same dimensions as the stage on which the two lines are drawn with a fine pen, and a circular portion in the centre made removable by a hinge or otherwise.

The indicator itself is a slip of paper the same size as the slide, viz., three inches by one, as seen in fig. 1, and has two

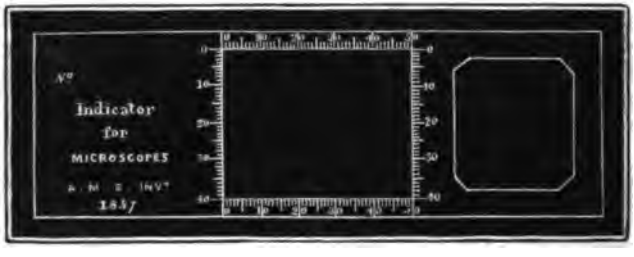


Fig. 1.

lines drawn across it, one inch from each end, which are graduated in fiftieths of an inch. At one tenth of an inch from each side, a line is drawn connecting the others, and these are also graduated in fiftieths of an inch.* By this arrangement the horizontal lines, which are numbered from left to right, bear the figures 0 to 50; and the perpendicular ones, in which they run from top to bottom, from 0 to 40.

On one end of the paper is a space for the number of the slide, and on the other, one for the description of the object mounted thereon. The blank space of paper between the scales is cut out, and after writing (in the parts assigned to them) the number and description of the object, the indicator is fastened to the glass slide with its face to the opposite side to which the object is; so that the graduations can be read through the glass, which serves to preserve both them and the label from being soiled.

When we wish to use the indicator, we have simply to place the slide on the stage; and when we find an object that we wish to register, we bring it to the centre of the field of vision, and then observe what numbers the two lines (as *a a'* and *b b'*, in fig. 2), ruled on the stage or card cut.

For instance, in the figure they cut 40 in the horizontal scale, and 15 in the perpendicular one; and, supposing the

* The United States inch is the same as the English.

object to be a *Pinnularia grandis*, we register it thus,—*Pinnularia grandis*, $\frac{10}{15}$, together with the number of the slide.

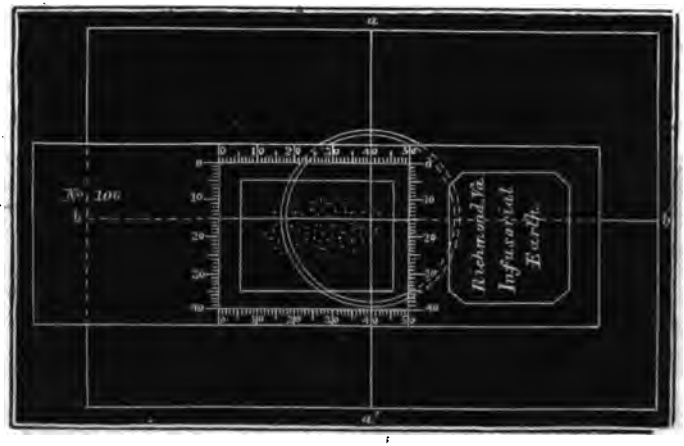


Fig. 2.

I have found it very often convenient to write them on the back of the indicator itself.

When the lines on the stage do not exactly correspond to one of the lines in the graduations, but fall between them, we can, with safety, guess at the distance (thus 25, 5, or 25, 2), as I have found that, though in this case the object may not always, when it is looked for again, be found exactly in the centre of the field of vision, it will generally be within its limits. Sometimes, however, the slide may be shifted, so as not to lie parallel with the registering lines, and, consequently they will not cut the same numbered graduations on opposite scales; thus, they may cut 30 in the upper horizontal line and 20 in the lower, 10 in the right hand perpendicular line and 20 in the left; in this case we register it thus $\frac{30}{20}\times\frac{10}{20}$, or else bring it so that they will coincide. In the example given it would be 25 in the horizontal and 15 in the perpendicular lines.

It will be noticed, that though there may be faults in the graduation of this indicator, it will not make any essential difference in its use, as the indicator is never removed from the slide which it registers, and therefore, as I before mentioned, it fulfils the sixth condition of the committee, and can be made by the microscopist himself.

I herewith send a few impressions of this indicator, with

the hope that this little contrivance may prove of as much use to others as it has been to me, cheerfully submitting it to the consideration of microscopists.

My second instrument I desire to call a *registrar;* it is, in fact an indicator, adapted to the use of microscopes with mechanical stages only, and will be found represented in figs. 3 and 4.

In these illustrations (3 and 4) the stage is three inches by

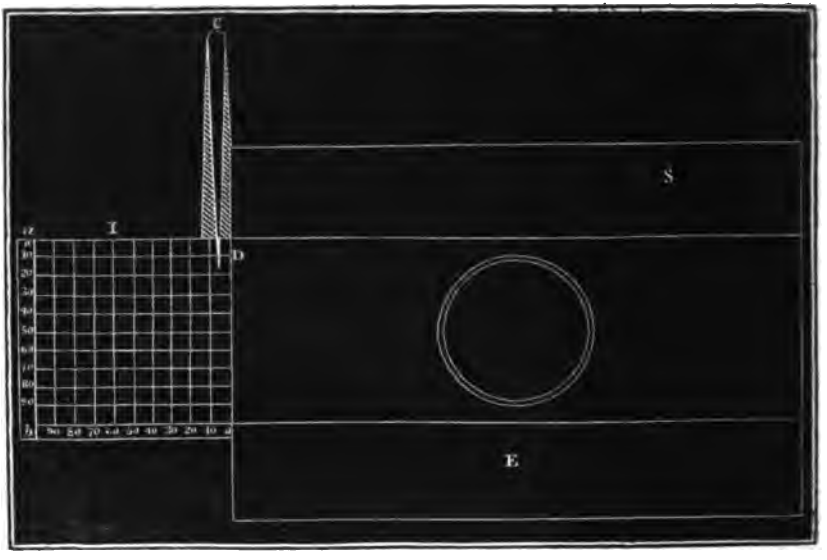


Fig. 3.

two, although, of course, this contrivance could be adapted to those of other dimensions. The stage, S, has a strip of brass, E, fastened to it, of the thickness and length of the glass slides. This strip is arranged, at one half an inch from a line drawn through the centre of the circular hole in the stage, so as to bring the centre of the slide into the middle of the field of vision.

On one side of the stage, at one and a half inch from the centre, is fixed a piece of ivory, I, measuring one and one tenth of an inch each way, and ruled with lines cutting each other across at one fiftieth of an inch apart;* the side strip (as *a*, in fig. 3) is reserved for the numbers, which run from

* In the figure, the lines are represented at only $\frac{1}{10}$th of an inch apart, to save the engraver trouble.

top to bottom, and the bottom strip (as *b* in the fig.) is also reserved for the same purpose, in which they run from right to left.

Fig. 4.

When the slide is placed on the stage it rests against this ivory scale and the brass guide-strip, so that it coincides exactly with that of the field of vision. A strip of brass is now bent into the form seen in the figure, c, and fastened at one end to the fixed stage on which the other moves, at G. The other end is brought to a fine point, and is blackened, so that it can be easily seen upon the ivory registrar. This strip or pointer is so arranged that when the moveable stage is brought perfectly square with the fixed one, its point rests at 50 in the upper zero line.

From an examination of the figures, it will be at once seen that, as the stage is moved in any direction, the registrar moves under the point, and when we find an object which we wish to register, we look at the pointer and observe the lines it points to, and write them down in the form of a vulgar fraction, *i. e.*, the numbers on the scale *a*, above the line, and those on *b* below.*

This registrar will be found to be of use on searching a slide for the first time, as we can begin at zero and travel across to 10; then, falling one or two graduations, we return across the scale, noticing the object by the way, and in this manner we traverse the whole portion of the slide upon which the objects are placed.

This instrument will not be of so extensive an application as the one first described, but still it would be found useful when attached to microscopes having mechanical stages.

* I should perhaps mention that I have found the best substance for attaching the paper indicator to glass slides to be the so-called "mucilage" sold at stationers' shops.

An Adjustable Index Point *for the* Scale *to be used as a* Marker. By W. K. Bridgman.

In carrying out the principles laid down by the committee appointed by the council of the Microscopical Society, I have succeeded in producing an arrangement capable of doing double duty—serving as a "marker," and, at the same time, being an index to the scale as a "finder"—so that either or both may be used upon the same object at any time without requiring a separate carrier, or interfering with any of the arrangements either of the slide or the object-glass.

Now, although a mark upon the label, or on the end of the slide itself, may be held to be inadmissible as a *permanent* record, abundant proof has already been afforded that, by the present contrivance, much time may be saved, and the ordinary use of the microscope greatly facilitated.

I look upon the objects we are seeking to attain as twofold:

1st. To save one's own time; and

2d. To secure identity, either for oneself, or to enable other observers to find with certainty the particular specimens intended for their examination.

As securing both these important objects, I offer a plan which is almost instantaneous in action, both for "marking" and for "finding," and so easy of application, that it may readily be used by the veriest tyro in microscopic manipulation. It is also simple in construction, and capable of being applied to every form of instrument. But as very few microscopists are mechanics, no plan can be fully carried out unless our London makers take up the subject, and include finders in the purchasable furniture of the microscope.

The method of arranging the index, as described in the report given in your number for October last, p. 95, leaves the space between this and the centre of the field an arbitrary distance. In our own plan, this space is fixed at *one inch from the object, in a line parallel with the lower edge of the slide.* The reason for taking this standard of measurement is that, as the ordinary slides (three inches by one) contain three square inches, allowing the centre inch for the reception of the objects and their cover, a square inch will remain at each end, to be used either for the label as a marker, or to be covered by the scale as a finder; and any two points, one inch apart in the same horizontal line (measuring from any point in the middle inch to any position in the other inch at

either end), will be represented, in exactly a corresponding position the counterpart of any spot in the one must of necessity fall within the area of the other. In our finder, this distance being first determined upon, a slide prepared for the purpose, is transferred to the instrument, which then becomes the medium for measuring a similar distance upon any other slide. The arm, A, fig. 1, carrying the index, is made a fixture to

Fig. 1.

the instrument, and is brought to the right side of the object-glass as the most convenient position. The index itself, B, fig. 1, is a piece of steel wire, about one tenth of an inch in diameter, and an inch and a half long, sliding up and down in a brass tube, C, at right angles to the end of the arm, A, and vertical to the stage plate. It is also adjustable by the two screws, D, D, which unite them. This wire is filed to a point, notched at the bottom with two grooves crossing each other, and may be raised or lowered by the cross pin, E, working in guide slots at the upper end of the tube, which is also cut and sprung at the lower end to prevent lateral motion. The point is thus kept always in the same relative position, and may be easily adjusted by the following process:

Take a plain glass slide, and paste or gum a strip of paper upon it, about two inches and a half in length, as in fig. 2, A.

Draw a line parallel to, and half an inch from, the lower edge of the slide. On this line make a minute hole, an inch and a half from the right hand end, and, with a pair of compasses set correctly to an inch, place one of its points in the hole, and, inking the other point to render the spot conspicuous, mark the place on the right hand end of the slide. There will now be one mark—a minute hole, B, near the centre of the slide, and another—an ink spot, C, one inch to the right of it. Place this slide upon the stage, using the clip to keep it steady in its place, having first adjusted the stage plate perfectly square, and the body of the instrument, if moveable, well up to the stop. Bring the hole, B, into focus, and as near to the centre of the field as possible; then adjust the point of the index, B, fig. 1, accurately over the centre of the ink spot, and tighten the screws, D, D, to fix it in that position. The papered slide being removed, and any object mounted on a slide, with a plain paper label, F, fig. 1, previously fastened upon it, being now brought into the centre of the field, raise the style or index, B, fig. 1, and, with a common pen dipped in ink, touch its point, press it down gently till it touches the paper label for an instant, and a neat, little, round dot will be the immediate result. *At any future time, by merely placing this dot, as* 5, fig. 2, *again under the point by which it was pro-*

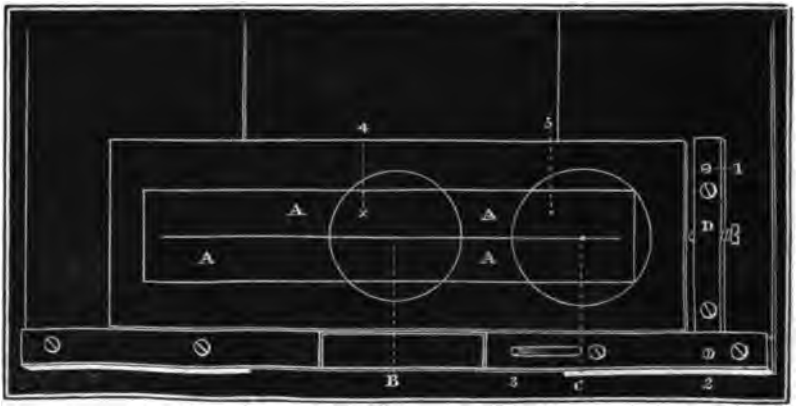


Fig. 2.

duced, and which may be done in a few seconds, the object 4, fig. 2, *will of course occupy its former position in the centre of the field.*

In arranging a cabinet of Desmidiæ, Diatomaceæ, or any

other mixed objects, mounted dry or in any stiff medium, it is far better that every species should be represented by one or more slides, ignoring, as much as possible, everything else they may contain, and this plan affords by far the readiest and quickest means of accomplishing this end; and with reference to larger or even conspicuous objects, which, when placed upon the stage, are prevented from being seen by the setting of the object-glass, and are thus often troublesome to get into the field, it will be found an invaluable assistance.

The same label may contain both the name and the dots of registry, and different coloured inks may be used for different objects, as well as labels be put upon both ends of the slide, and no reference having to be made elsewhere, the object can be placed at once upon the stage in its proper position.

The label should be somewhat larger than the cover, and fixed upon the slide with its centre as near an inch from the centre of the cover as possible. This may readily be done by using another slide as a measure, holding it crosswise behind the one to be labelled, so that the two edges bisect the cover and the label equally.

To prevent the labels becoming detached, *the slides must be perfectly cleansed from grease and the paper thoroughly damped prior to using*. A few hours' confinement in a tin box with damp sand will render the ready-gummed labels well conditioned for adhering. The only objection that can be urged against using the label is the possibility of its being lost, but this can only arise from defective manipulation.

To complete it as a finder with a scale, the first step will be to provide a stop, D, fig. 2, on the right side of the stage plate. This should be so adjusted, that when the hole, B, in the papered slide is in the field, the movements of the stage shall be central, and the slide in the middle of the stage

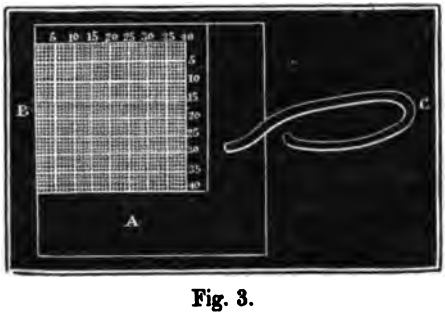


Fig. 3.

plate. A very thin plate of brass, A, fig. 3, about an inch

and a quarter square (upon which the paper scale is afterwards to be fixed), is now made to rest over the right hand end of the slide, but without touching it, lying upon the stage-bar at the bottom, and the end bar or stop, D, at the side. Instead of being a fixture in this position, three steadying pins, soldered into the under side of the plate, A, fit into corresponding holes, 1, 2, and 3, fig. 2, in the stop and stage bar, and keep it perfectly steady and tight, and yet, by means of the handle, C, fig. 3, allow it to be taken off or replaced in an instant. A channel or groove leading to the left-hand hole, 3, fig. 2, of the stage bar, serves as a guide for directing the pins to their proper places, and if a medium thickness of slide be used, the plate may be fitted so close upon it as not to be in the way of the object-glass. Upon the brass plate, A, fig. 3, fasten the paper scale, B, either with paste, gum, diamond cement, or shell-lac. The hole, B, in the papered slide, being in the field, and the slide close to the stop and the stage bar, put the centre of the scale carefully under the point of the index, and see that the horizontal lines are parallel with the lower edge of the slide, by passing the scale backwards and forwards under the index; or, in this way its place may be accurately ascertained and marked beforehand.

As covers are seldom required larger than three quarters of an inch in diameter, the scale, B, need be only nine tenths of an inch square; eight tenths being used for the divisions, and one tenth at the bottom and right hand side being occupied by the numbers. The divisions being fiftieths of an inch, there will thus be only 40 each way, and the centre will read 20, 20, the first number referring to the top of the scale, and the right-hand number to the right-hand side of the scale.

As a finder, in its application to an instrument devoid of stage movements, an additional loose stage plate, similar to fig. 2, will be required to carry the scale and the stop, but used merely as a marker, the usual sliding stage-bar will suffice.

A piece of common looking-glass, about an inch square, G, fig. 1, attached to the body of the instrument on the left side, by a split ring, may be made to throw light from the lamp upon the label or scale, and render the marks legible without interfering with the object-glass.

Although where this instrument has been already applied, the same form and position have been retained, it by no means follows that other arrangements may not be found equally if not more convenient; as, for instance, the adjusting screws, D, D, fig. 1, may be made to work with milled nuts,

and the arm, A, fig. 1, may be attached either to the base of the stage, the side of the swinging frame of the bar, or even to the bar carrying the body and slow motion. In the latter case it will require the style to be longer, and to have a greater range of vertical movement, or a separate adjustment may be required to meet the extreme variation in the different lengths of object-glasses. In every case, whether used as a marker or finder, changing the object-glass will necessitate the papered slide, fig. 2, being first applied to test the relative positions, and if the object be in any part of the field, it will be easier to allow for this than to alter for every occasion, but as most observers work principally with the quarter, this will seldom be required.

By description, even with the assistance of figures and diagrams, it is generally extremely difficult to render the action of any mechanical contrivance so intelligible as to be readily comprehended. In the present case, however complex and tedious it may appear, simplicity is one of its greatest merits, and when seen in use has invariably won for it instant approval. All the minutiæ, so far as I can find, have been given for its construction, but should any further explanation be desired, I shall have much pleasure in replying to any communication on the subject.

On a former occasion, a slight but important omission led to an unfavorable conclusion. In his work on the microscope, Dr. Carpenter, in quoting from a previous number of the Journal, our contrivance for scratching circles upon the glass, objects to the use of a diamond, as liable to cut or star the cover. Omitting to state that the splinter of diamond should have its point rubbed once or twice on a piece of Turkey stone, to give it a *scratching* instead of a cutting edge, might reasonably lead to the above conclusion; but with this precaution no fracture has ever occurred, and we have marked test-objects under the thinnest covers as delicately and as perfectly as can be wished for.

TRANSLATIONS.

CONTRIBUTIONS *to the* HISTORY *of the* DEVELOPMENT *of the* SPONGILLÆ. By N. LIEBERKÜHN. (Müller's 'Archiv,' 1856, pp. 1—19, 319—414.)

OF the above long and valuable communication we have space to give only the following abstract.

The constituents of the *Spongillæ*, which have up to the present time attracted the attention of observers, are the following:

1. The skeleton, consisting of siliceous spicules of various forms.
2. The interstitial gelatinous substance.
3. The *gemmulæ*, as they are termed, furnished with a pore, and having either a smooth shell or surrounded by *amphidiscs*.
4. Motile corpuscles occurring at certain seasons, and which are supposed to effect the reproduction of the sponge, and which, according to Hogg, move in consequence of an endosmotic action, and, according to Laurent, by *cilia*.

As regards the marine sponges, Grant notices similar corpuscles, which are ciliated at the anterior end, but not posteriorly; Quekett, however, states that he is unable to confirm this observation, and gives a totally different exposition of the mode in which reproduction is effected. Spermatozoa have been described in *Tethyum* by Huxley, and by Carter in *Spongilla*.

Lieberkühn's observations were almost exclusively confined to *Spongilla fluviatilis*.

1. With respect to the skeleton, Lieberkühn observes that the spicules are not united at the base by a siliceous material, as stated by Meyen, but by a substance destructible by heat. The spicules are usually arranged in aggregate bundles, which meet point to point at an obtuse angle, and project slightly above the surface of the sponge.

Minute portions of the gelatinous substance exhibit under the microscope *amœba-like* movements, respecting which it is unknown whether they are vital phenomena, as supposed

by Dujardin, or referable to a process of decomposition. Other portions presented on part of their surface a kind of long *cilia*, by means of which they moved rapidly from place to place, throwing out, at the same time, processes from the non-ciliated part of the surface, and again retracting them, exactly as do the *Amœbæ*. Lieberkühn never observed the ciliated particles in the winter, nor before the spring; in the former season he noticed only those exhibiting the amæba-like motion. But these portions, which are always to be obtained when a living *Spongilla* is spread out upon the object-glass, are by no means amorphous masses, as figured by Dujardin, but among them may frequently be recognised structures having the form of a cell; and this is the case more especially in the winter, at which time the granular substance is less abundant. When the amæba-like movement has ceased, these bodies are seen to contain a *nucleus* and *nucleolus*. The entire sponge is composed of this kind of substance. Though employing for convenience the term "cell," Lieberkühn states that he has never succeeded in discerning a "cell-membrane" around these particles. Among these "cells" he often observed bodies containing foreign substances, such as *Bacillariæ*, &c., but which, in other respects, fully resembled the sponge-cells, and were also furnished with a nucleus, though unprovided with a contractile vesicle. They protruded and retracted motile processes, and it is not impossible, he thinks, that they may really be *Amœbæ*, which are sometimes without a contractile vesicle. Actual *Amœbæ* with a contractile vesicle are by no means rarely contained in the sponge.

The *Spongillæ* in general, especially in winter, are the habitation of an abundant infusorial life; he has observed abundance of *Paramecium aurelia, P. colpoda, Chilodon cucullulus, Trachelius, Amphileptus, Prorodon, Loxodes*, &c.

THE GEMMULES.

The living *Spongillæ* are often seated, not immediately upon the wood, stone, &c., upon which they may be growing, but separated from it by a peculiar, dark-brown substance often several inches thick. This mass is composed chiefly of the remains of the dead sponge, empty gemmule-cases with their amphidiscs, various forms of siliceous spicules, &c.; and occasionally there may be found in it gemmules still retaining their brown colour and contents capable of development.

Dead *Spongillæ* are sometimes so thickly studded with gemmules as to present in consequence a gray or greenish

colour. In the lowermost layers of the living sponge, contiguous to the dead portions, there occasionally occur large quantities of glittering white gemmules, but, except in colour, otherwise like the brown ones, and containing, like them, spherical bodies, composed of larger and smaller fat-like granules and an albuminous substance. These bodies are about the size of the largest sponge-cells, and are readily broken up by pressure. Others, again, may be seen with a very delicate case, though furnished with very transparent amphidiscs, and in these gemmules the contained spherical bodies are less readily broken up. When a portion of sponge containing gemmules of this kind is torn asunder with a fine needle under water, some whitish, ill-defined, spherical portions, of about the same dimensions as the gemmules, will be noticed. They present the following characters:

They are constituted of two distinct substances, one external, having a low refractive power, something like the common sponge-cells, and an interior spherical mass, with strong refractive power, almost like collections of fatty particles. When one of these bodies is crushed, it breaks up into cellæform structures of two kinds, and both about the same size as the sponge-cells. Those of which the interior highly refracting part of the corpuscles was composed, cohere together, and are constituted of a motile sarcode substance. The outer layer appears to be composed of firmly agglutinated cellæform globules, some very closely resembling the sponge-cells in the disposition of the nucleus and nucleolus, whilst others inclosed amphidiscs. Some of the amphidiscs thus contained in the cells were perfect in form, and others obviously only in process of formation. The amphidisc-cells did not present any nucleus, but were very distinctly defined.

Occasionally Lieberkühn noticed among the white gemmules, some which, together with free amphidiscs, supported on their transparent investing membrane others contained in vesicles or cells. From what he observed, he concludes that the above-described bodies represent immature gemmules. He is unacquainted with similar phenomena in the case of the smooth gemmules, remarking only that up to the present time he has never noticed, in one and the same portion of sponge, gemmules with amphidiscs together with smooth ones at the same time, although both forms occur at all seasons.

The usual contents of the gemmules have been described by Meyen (Müller's 'Archiv,' 1839, p. 83). In many instances Lieberkühn found that the globular arrangement no longer

existed, the globules being replaced by granules exhibiting an active molecular motion.

That the gemmules are formed from agglomerations of sponge-cells may be readily proved in the branched sponge containing smooth gemmules. In a longitudinal section of a suitable portion we find—

1. Gemmules which are perfectly developed and consist of a smooth case and numerous globular bodies, first accurately investigated by Meyen; each of these globular bodies contains an albuminous fluid and numerous highly refractive vesicles; it is about the size of a sponge-cell, and is rapidly disintegrated in water.

2. Gemmules having a distinct case, and containing, besides the globular bodies of Meyen, corpuscles resembling these, but differing from them in the circumstance that they throw out protean processes as do the sponge-cells.

3. Gemmules with distinct case, and furnished with a pore, and containing only corpuscles of the nature of those last described. Some of these corpuscles contain a nucleus and nucleolus similar to those of a sponge-cell, from which they differ apparently only in the circumstance that they are filled completely with the vesicles above described.

4. Spherical masses of the same size as the gemmules, and composed of the motile corpuscles just noticed and of distinct sponge-cells. These sponge-cells have a distinct nucleus and nucleolus, and besides these, contain a very finely granular substance, dispersed either uniformly throughout the entire cell, or collected into minute spherical masses; these spherical masses have the same dimensions as the vesicles above referred to, and in many cells they are associated with several of these vesicles. On many of the spherical agglomerations of cells an excessively delicate structureless membrane may be already noticed.

It would appear, therefore, that the "globules" of Meyen are nothing more than altered sponge-cells.

The autumn is the most favorable season for observing the process of their formation.

With respect to the destination of the contents of these gemmules, Lieberkühn first quotes Mr. Carter's observations recorded in the 'Annals of Nat. History' (2d ser., vol. iv, p. 81, 1849), whose description of the mode of formation and composition of the gemmules pretty nearly accords with his own, and then proceeds to say that he has never succeeded in causing the expressed contents of the gemmules to

become developed. He has never seen sponge-cells produced from them in the way described by Mr. Carter, and asserts that the process of development is entirely different from that stated by that observer. The first change in the gemmules was noticed in March. The cells no longer liquefied as before in the water when expressed from the gemmule, and exhibited amæba-like motions like the common sponge-cells. In many of the cells two nuclei with nucleoli might be observed, and, upon the whole, the larger vesicles did not contain so many cells, and presented a greater proportion of finer granules.

He placed a number of these gemmules in watch-glasses, and exposed them to the sun for some time every day. In a few days a fine white deposit might be seen surrounding some of the gemmules, which was found, under the microscope, to be composed of an agglomeration of coherent sponge-cells, which was still in connection with the contents of the gemmule through its pore. This substance was firmly adherent to the bottom of the glass. In other gemmules the extracted cellular substance was situated, not on the side next the glass, but upon the upper side,—in fact, wherever the pore was placed. The escape of the cellular substance was very slow, so that the case was not completely emptied under four days. The development of the sponge, therefore, would seem to take place by the escape of the contents of the gemmule through the pore. The external surface of the cellular mass thus protruded gradually becomes transparent, no longer exhibiting the large vesicular structure it before possessed, and presenting instead the minute granules characteristic of the common sponge-cells. Conical perforated eminences afterwards make their appearance upon this nascent sponge-substance. The same process takes place in the gemmules which have been retained within the horny skeleton of the sponge; but in this case the cellular substance produced from each gemmule coalesces with that from the contiguous gemmules, and the whole forms a continuous mass, which necessarily assumes very much the form of the original sponge, owing to the circumstance that it is deposited upon the old skeleton.

The commencement of the formation of spicules was observed by Lieberkühn about the sixth day after the expulsion of the contents of the gemmules. On breaking up the cellular substance, extremely delicate needles might be observed, some of which were smooth, whilst others presented a rounded swelling in the middle. The further development of these spicules will be noticed below.

Lieberkühn notices four kinds of gemmules characterised respectively by their cases or shells:

1. Those with smooth cases.
2. Those with stellate amphidiscs.
3. Those with amphidiscs, in which the discoid extremities are entire and not stellate.
4. Gemmules, whose case, instead of amphidiscs, is furnished with minute, usually slightly curved, siliceous spicules.

MOTILE SPORES.

[Besides the gemmules above described, other reproductive bodies are met with in *Spongilla*: 1. Some, which from their resemblance to the motile spores or zoospores of many plants, have also been termed "schwärm-sporen," or "motile spores;" and 2 others, which, from their resemblance to the spermatic filaments elsewhere met with, are, as it would appear, properly denominated "zoosperms," or "spermatozoids."]

These bodies are thus described by the author, who states that he first discovered the "motile spores" after having left some recently collected *Spongilla* for a few hours in a vessel filled with river water. They are recognisable by the naked eye, having a longitudinal diameter of pretty nearly two thirds of a millimeter, and of one fourth in the greatest transverse diameter. They vary, however, considerably in size, and are of an ovoid form. In most of them, without the aid of glasses, a transparent hemispherical space may be perceived in the anterior, and a brilliant white space in the hinder part of the body. These terms are applied, because in swimming the weakly refractive part precedes, and the other follows. The spores move actively about in all directions. After existing about two days in this motile condition, the spores become quiescent and subside to the bottom, where most of them perish altogether. They rarely become developed.

On the twentieth day, in a successful observation, the author noticed that the spot formed by the subsided spore was increased in size, and upon examining this, it was found to exhibit the constituents of the young *Spongilla*, that is to say, protean cells, smaller and larger spicules, and a few germ-granules.

The movements of the spores were effected by means of cilia, uniformly distributed over the surface, and in length about the same as those of the Turbellaria, though perhaps still finer. But what distinguishes them essentially from the

ciliated coverings of all Infusoria as yet known, and that of the Turbellaria, is a kind of epithelial layer upon which they are seated. This epithelium is composed of a single layer of spherical cells, about $\frac{1}{300}$ mm. in diameter, and which, though touching each other, are not in such close contact as to lose their rounded figure. Sometimes portions of this ciliated epithelium may be seen detached, and such detached fragments are often apparent in portions of the sponge which have been torn to pieces. They must not be confounded with the spermatozoids which sometimes adhere to detached amæba-like fragments of the sponge under the same circumstances. Beneath the ciliated epithelium is a layer of sarcode, within which is contained what the author terms the medullary substance, which is of a spheroidal form, and occupies the whole interior of the spore. Its appearance differs greatly in different spores. The whole spheroid, which is whiter and more opaque at the hinder part, lodges extremely delicate siliceous needles, many of which, even at this time, exhibit the perfect form of the mature spicule. These siliceous needles are not disposed with any regularity in the spore.

The main differences in the contents of the "motile spores" arise from the greater or less abundance in them of "germ-granules." The fully formed "germ-granules" are usually spherical, more rarely lenticular. They attain a size of about $\frac{1}{75}$ mm., but some much smaller are met with. They exhibit a strongly refractive envelope and contents, which appear, when distinct, to resemble an ill-defined gelatinous globule. The number of these "granules" varies extremely in different spores. They are sometimes also assembled into little rounded masses, composed of three or more together. These conglomerated germ-granules may sometimes be seen, together with the siliceous spicules, escaped from the spore, and inclosed in a mucous, structureless case. Conglomerated granules of this kind are found in vast numbers in various parts of the *Spongilla*, but especially towards its base. But in all these instances the author has invariably also observed the ciliated spores. They appear, according to Lieberkühn, to correspond with the isolated groups of germs, which, according to Carter, pass into the protean cells; but an essential discrepancy arises with respect to this, from the circumstance that this observer states that the groups of germs are produced immediately from the gemmules. This is at present unexplained.

The zoosperms.

Besides the ciliated bodies above described as being the agents of motion of the "motile spores," Lieberkühn ob-

served not unfrequently great numbers of moving corpuscles in sponges which had been torn up, which could be readily distinguished from them. They had, for instance, a far longer and thicker filament, and a much smaller head. They "swarm" usually in numbers together, with the heads in contact, and in their motions closely resemble the well-known spermatozoa. They arise from spherical receptacles, surrounded with a structureless transparent tunic, around which are disposed the sponge-cells. These receptacles are about $\frac{1}{12}$ mm. in diameter. The author was unable to prove their nature to be that of spermatozoa, and all his endeavours to witness their penetration into the pore of the gemmule, as a kind of micropyle, were bestowed in vain.

The peculiar bodies described by Carter, under the same name, are considered by the author to bear no resemblance to those noticed by himself, inasmuch as they are much larger and have a contractile head. He has noticed bodies in the course of the winter, corresponding with Mr. Carter's figures, but these he regarded as larger or smaller specimens of *Trachelius trichophorus*. But it is otherwise, he observes, with respect to the corpuscles described by Huxley, in Tethyum, as spermatozoids; these, he says, strikingly resemble those of the *Spongillæ*.

Abstract of "OBSERVATIONS *on the* REPRODUCTION *of the* RHIZOPODA." By Prof. MAX. SCHULTZE. (Müller's 'Archiv,' 1856, p. 165.)

IN the author's work on the 'Organization of the Polythalamia,' he was in a condition merely to throw out surmises with respect to the mode of reproduction of these animals; but a supply of living Gromiæ—Rotalidæ and Miliolidæ—having afforded him an opportunity of making numerous observations on this subject, he now publishes the results at which he has arrived.

Remarking that an individual belonging to the genus *Triloculina* (D'Orbigny) had become stationary for several days, and enveloped, as is not unusual, in a thin layer of brownish slime, he paid particular attention to it. At the end of a few days after it had become quiescent, the author noticed that minute spherical, sharply defined granules were detached from the brownish slimy envelope, and in the course of a few hours the animal was surrounded with about forty of these corpuscles, which gradually became more and more widely separated from it. Microscopic examination of these bodies proved that they were young *Miliolidæ*. When viewed by transmitted light, they presented a pale yellowish-brown calcareous shell, consisting of a central, globular portion, partly surrounded by a closely applied tubular part, and having no septum in the interior. In a short time the young animals protruded their contractile processes from the anterior opening of the shell, and crawled about upon the object-glass. The parts of the body enclosed in the transparent shell could be examined with great accuracy under the highest magnifying powers, and were seen to consist of a transparent, very finely granular, colourless material, of which the protruded filaments were an immediate continuation, and in which were imbedded minute, sharply defined granules, protein- and fat-molecules, some of considerable size, and angular, like the vitelline plates in the ovum of fishes.

He was unable to perceive in the young *Miliolidæ*, either vesicular particles, as cells, or a contractile vesicle, nor could he recognise any distinctly defined nucleus. Nor did the application of different chemical reagents, especially of a dilute solution of chromic acid—by the aid of which it is easy to demonstrate that the body of the *Hydra* is composed of cells, as shown by Leydig (Müll. 'Archiv,' 1854, p. 270)—enable him to discern any other elementary parts in the body

of the Polythalamia than those previously pointed out by him in his former work.

The latter half of the tubular volution of the shell is not completely occupied by the animal substance, whilst the central portion is densely filled. In this situation, also, the oil-drops are accumulated to such an extent as materially to interfere with the transparency of the substance, in consequence of which it is necessary, in making a more particular examination of the contents, to break up the shell and express the contents. Even under these circumstances, no nucleus could be perceived, such as may always be so readily demonstrated in *Amœba*, *Difflugia*, *Gromia*, &c., as is known to be present in many, if not most, others of the Protozoa.

But of nuclei of this kind the author has hitherto never been able to perceive any trace, not only in the young *Miliolidæ*, but also in other Polythalamia.

From the circumstances under which the young *Miliolidæ* made their appearance, it might be concluded that they must necessarily quit the parent in a tolerably perfect condition, and that it was probable they acquire the calcareous shell whilst still within the mother.

Professor Schultze was next led to inquire further into the mode in which the young originated. When the calcareous shell of the parent animal was carefully broken up, it was found to contain only trifling remains of a fine granular organic substance, which, after patient and prolonged observation, exhibited no trace of motion in delicate sarcode-filaments, such as is often, under other circumstances, presented in separated particles of the animal substance. Nor could he perceive any vestige of a body which could be regarded as a young one in process of development. The almost complete absence of any organic contents in the shell of an individual which 8—14 days previously was creeping about, renders it probable that the whole, or, at any rate, the main part of its body, had been transformed into young ones, a supposition which other observations had led the author to propound in his former work (p. 26), where he describes polythalamian shells in which most of the chambers were densely filled with dark-coloured globules, which might fairly be supposed to represent germ-granules.

In his recent researches, however, recorded in the present paper, he appears to have met with only a single *Polythalamian* which was filled with similar globules. This belonged to the species formerly described by him under the name of *Polymorphina silicea*, from the circumstance that its shell was siliceous, although itself possessing the form of a *Nonionina*.

In this instance all the chambers in the ultimate volution were filled with strongly refracting globular bodies, 0·018″ in diameter, and of which 6—8 were contained in the larger and 3—5 in the smaller chambers. These bodies exhibited a peculiarly brilliant envelope, which, upon further examination, by means of acid and the breaking of them up, was found to be solely composed of minute siliceous particles. There were no other animal contents in the chambers. These globular bodies, he sees reason to regard as embryos furnished with siliceous capsules, and which might be supposed to be formed out of the contents of the chambers in the same way that the *Navicellæ* are formed in a *Gregarina*, and to be destined, on their liberation from the parent, to become the central or primary chamber of the future Rhizopod.

Should this prove a correct interpretation of the nature of the globular bodies, it would appear, as regards the genesis of the siliceous shell of these Rhizopods, that it is not composed of a collection of siliceous fragments, but that the animal itself must be capable of secreting siliceous matter in the form of very minute granules.

In conclusion, he adverts to the observations of P. Gervais (published in the 'Comptes rendus,' ii, p. 467, 1847), respecting the reproduction of the Miliolidæ, and which are fully confirmed by his own observations now recorded. Gervais states that the sexes are distinct in these animals, and asserts that he has witnessed their conjunction in pairs previous to the act of parturition. How far these statements are correct, Professor Schultze leaves to be determined by future researches.

REVIEWS.

On a True Parthenogenesis in Moths and Bees, a contribution to the history of Reproduction in Animals. By CARL THEODOR ERNST VON SIEBOLD. Translated by WILLIAM S. DALLAS, F.L.S. London, Van Voorst.

THE whole theory of reproduction, as it occurs in plants and animals, has undergone curious and interesting changes, according as new observations have been made from time to time. Amongst the earlier naturalists sex was only recognised amongst the higher animals, and the lower animals and plants were supposed to be produced by a process of budding. Gradually, however, it became evident that amongst the lower animals sexes existed, and at length the discovery was made of the true relations of the pollen of plants to the ovules contained in the pistil. Then followed the sexual system of Linnæus. But Linnæus was not aware how far the antagonistic cells existed amongst the lower plants, and it has been the discovery of microscopists of recent times that sperm-cells and germ-cells exist in the Linnean Cryptogamia. So far have these discoveries been extended in both the animal and vegetable kingdom, that it would appear to be a general law that no true species of animal or plant is renewed without the union of sperm-cells and germ-cells. But whilst these observations were going on, many curious instances of anomalous production of individuals were observed. Steenstrup drew attention to the fact that many animals, whilst passing from their youngest to their adult forms, produced new individuals without any union of germ-cells and sperm-cells. Such animal forms he called "nurses." Professor Owen observed the phenomenon of "nursing" with great care in the well-known plantlouse (*Aphis*). In these creatures, the young, generated by the union of the sperm-cell and the germ-cell, produce young, resembling themselves, for eight or nine generations without any union of the two opposite cells. This Professor Owen calls Parthenogenesis.

In the work of Professor Von Siebold, translated by Mr. Dallas, we have an account of the production of bees and moths from eggs which have been produced independent of any contact of the sperm-cells with the germ-cells. To this process of genesis, in which eggs, capable of producing the perfect form of the parent, Von Siebold proposes to apply

the term Parthenogenesis, and calls it "true Parthenogenesis." It is, we think, to be regretted that the German Professor has thus attempted to apply a term, invented by Professor Owen, to another and different set of cases, denying its applicability to the instances for which it was invented. We give Von Siebold's explanation of the facts as they occur amongst Aphides:

"Not to deviate too far from the object which I have set before me in these pages, I will only here give prominence to that in the history of insects which people have been induced to regard as a peculiarity of the alternation of generations—I mean the remarkable reproduction of the *Aphides;* this, after standing so long as something quite abnormal and inexplicable, has now found its complete explanation in the nature of the alternation of generations. It is well known that in the *Aphides*, a sexual generation, represented by separate males and females, is followed by a series of generations, only including a single form, which proceed from each other in manifold repetition without any previous copulation, until after about seven to eleven such generations, a generation of males and females again makes its appearance. Steenstrup regarded these forms of *Aphides*, which are capable of reproduction without the influence of the male generative organs, and which had previously been looked upon as virgin female *Aphides*, as nurses (*Ammen*), and consequently as those members of an animal species subjected to an alternation of generations, which are capable of producing young in the asexual (or larval) state. Those *Aphides* which bring forth living young without a preliminary copulation, are in reality quite different in their organization from the true female *Aphides*, which lay eggs capable of development after the act of copulation. In the viviparous *Aphides* those organs especially from which the living young are produced, have quite a different form and organization from the sexual organs of the oviparous female *Aphides*, so that, in opposition to the *ovaries* (*Eierstöcke*), the products of which (eggs) only become capable of development by the action of the male semen, we may with perfect justice indicate these organs as *germ-stocks* (*Keimstöcke*), which are capable of producing young of themselves, without the influence of male fertilizing organs. These nurse-like, viviparous *Aphides* therefore, which instead of ovaries bear germ-stocks in their interior, are also destitute of the seminal receptacle, which occurs universally in the females of insects and plays an important part in the act of fecundating the eggs. Before the alternation of generations had yet been introduced into science by Steenstrup, I had already called attention to the different conditions of organization in the oviparous and viviparous *Aphides*, and especially to the absence of the seminal receptacle in the latter. Subsequently the development of the *Aphides* without fecundation has been completely explained by V. Carus as a process of the alternation of generations. The representation which Carus has given of the development of germinal bodies in the germ-stocks of the viviparous *Aphides*, has certainly met with a refutation from Leydig, against which I have nothing to object; nevertheless, although, according to Leydig, the young are developed from the germ bodies of the viviparous *Aphides* exactly as from eggs, by cell-formation, I would retain the denominations "germ-body" and "germ-stock" for these reproductive organs of the viviparous *Aphides*, in order to distinguish them, on account of their different physiological import, with regard to the alternation of generations, from the eggs and ovaries of the oviparous female *Aphides*.

"Owen has regarded the asexual viviparous *Aphides* as virgin females

capable of reproduction; but these viviparous *Aphides* indicated by Owen as virgin parents are certainly something very different from the oviparous *Aphides* in their virgin state before copulation. For the same reason also I cannot approve of Owen's expression *Parthenogenesis*, as applied by him to the alternation of generations, as under the term Parthenogenesis I do not understand reproduction by asexual nurse-like or larval creatures, but a reproduction by actual females, that is to say, by individuals furnished with perfectly developed, virgin female organs, which produce eggs capable of development without previous copulation and in an unfecundated condition."

Although the production of perfect insects from eggs deposited by unimpregnated females, had been suspected by previous observers, so large a number of observations has never been recorded before as those now presented by Professor Von Siebold. After showing that this phenomenon must certainly be regarded as true in a number of species of sac-bearing Lepidoptera, belonging especially to the genus *Psyche*, he proceeds to give a detailed account of its existence in the honey bee (*Apis mellifica*). That worker-bees (the unfecundated females) and unfecundated queen-bees lay eggs which are capable of being hatched into drones or male bees, has long been known or suspected to exist by those who keep bees, is proved by the statement of a bee-keeper (Dzierzon), who, in 1849, published an essay on the subject. In this essay, quoted by Siebold, he says—

"Therefore, and this must be well borne in mind, in the copulation of the queen, the ovary is not impregnated, but this vesicle or seminal receptacle is penetrated or filled by the male semen. By this, much, nay all of what was enigmatical is solved,—especially how the queen can lay fertile eggs in the early spring, when there are no males in the hives. The supply of semen received during copulation is sufficient for her whole life. The copulation takes place once for all. The queen then never flies out again, except when the whole colony removes. When she has begun to lay, we may, without scruple, cut off her wings; she will still remain fertile until her death. But in her youth, every queen must have flown out at least once, because the fertilization only takes place in the air; therefore no queen, which has been lame in her wings from birth, can ever be perfectly fertile: I say, perfectly fertile, or capable of producing both sexes. For, to lay drone-eggs, according to my experience, requires no fecundation at all. This is exactly the new and peculiar point in my theory, which I at first only ventured to put forward as a hypothesis, but which has since been completely confirmed. Three young queens with imperfect wings have occurred during the past summer, and these, although, from the imperfection of their wings, they could evidently never have taken the fertilizing flight, and also on dissection proved to be unfecundated, nevertheless laid drone-eggs.—By this, all the mysteries which we have hitherto vainly endeavoured to unriddle, are completely solved. In the first place the enigma: Why is it that many mothers—they may be either queens or workers in their form—are only capable of propagating the male sex or drones? Because the former are either unfecundated, or their fertility is exhausted; the latter, on the other hand, are incapable of fertilization."

The general facts of the case having been made out by the apiarians, both Leuckart and Von Siebold determined, if possible, to test these views by the aid of the microscope. Both observers were aware that in certain stages of the fecundated germ-cell, the filaments of the sperm-cell may be observed. If, therefore, the facts stated by Dzierzon and the other apiarians were true, the sperm-filaments ought to be detected in the eggs of the female or worker bees, whilst they would be absent from those of the male or drone bees. Leuckart was not successful in examining a large series of eggs, but he gives the following result of his investigation:

"On two occasions only I met with some undoubted seminal filaments upon the micropyle of bees' eggs; on one occasion a single filament, on the other several, four or five (and yet I have most carefully examined more than fifty bees' eggs!). On both occasions it was upon worker-eggs that I found the seminal filaments. In drone-eggs I have never been able to distinguish a seminal filament, although I probably examined more drone-eggs than worker-eggs, and amongst these such as had been laid at the utmost a quarter of an hour previously."

Von Siebold was more successful. He says—

"After various vain endeavours to render the interior of the bee's egg accessible to the inquiring eye, I came at last to the idea of employing an artifice, which I had soon acquired by practice, and which allowed me to survey at least a portion of the inner space of the bee's eggs with great clearness and tranquillity. I crushed a bee's egg quite gently with a very thin glass-plate, and so that it was ruptured at its *lower* pole, opposite to the micropylar apparatus, and the yelk gradually flowed out at this spot, by which a clear empty space was produced at the upper pole within the micropylar apparatus, between the egg-envelopes and the yelk which was retiring downwards. I directed my attention very particularly to this empty space, which I saw slowly produced under the microscope during the effusion of the yelk. The production of such a preparation of course was not always successful, for sometimes the yelk flowed out of the ruptured envelopes, without the production of this empty space; the yelk also remained diffused in the upper part, and allowed of no certain judgment as to the presence or absence of seminal filaments. An error in crushing the egg, a little too much pressure upon it, or perhaps also a peculiar, less tenacious consistency of the yelk, probably caused the contents of the yelk to retire in every direction from the pressure, and therefore also to press upwards against the micropylar apparatus."

Of the result of his examination of the female eggs he says—

"Amongst the fifty-two female bee-eggs examined by me with the greatest care and conscientiousness, thirty furnished a positive result; that is to say, in thirty, I could prove the existence of seminal filaments, in which movements could even be detected in three eggs. Of the other twenty-two eggs, twelve were unsuccessful in their preparation. At the same time I may also indicate particularly, that the observations with positive and negative results followed each other quite irregularly, but alternating at very short intervals,

which probably was only dependent upon the favorable or unfavorable consequences of my preparation of the eggs employed for observation. If the question is to be raised, why Leuckart was not so fortunate as to see what I have succeeded in seeing, I can make no other answer, but that probably the different method followed by us in our investigations, is to be blamed for Leuckart's want of success. Berlepsch informed me, that Leuckart did not examine the contents of the eggs by the careful compression of the bee's egg, but that he confined himself to submitting the eggs in a perfectly uninjured state to an external examination."

He also obtained drone-eggs on the same occasion. Of the examination of these eggs he says—

"I examined these twenty-seven drone-eggs, which might have been about twelve hours old, and which agreed perfectly both in their appearance and organization with the female eggs, with the same care and by the same method with which I had treated the female eggs, and *did not find one seminal filament in any single egg, either externally or internally*. I must also add, that only the seventh, thirteenth, and twenty-third eggs were unsuccessfully prepared. In all the rest of these drone-eggs the yelk retreated slowly and completely from the upper pole of the egg-envelopes, after the bursting of the membranes; the desired empty clear space between the micropylar apparatus and the retreating yelk was produced in the interior of these eggs, so that if seminal filaments had been present in them, they certainly would not have escaped my searching and inquisitive eye. In order to be quite satisfied as to this remarkable negative result, and to obtain the full signification of it, several female eggs of the same queen which had furnished these drone-eggs, were examined for comparison; for the objection might certainly have been raised, that this queen might have laid nothing but barren eggs, as, being already weakened by age and near her death, she might have had no more spermatozoids in her seminal receptacle. Nevertheless, many of these eggs contained seminal filaments; they were the twenty-seven eggs already mentioned by me,—namely, the sixteenth to the forty-second eggs."

It may be thought by some that these investigations are not conclusive, and perhaps they are not. But it should be remembered that the evidence on the other side is not a whit more conclusive. A naturalist confining his attention to the phenomena of sex as presented in the vertebrate animals, might bring against Von Siebold a verdict of "not proven;" but one acquainted with the phenomena of parthenogenesis in plants and the lower animals will be disposed to receive this evidence as of more value than the mere inference of the necessity of the influence of both sexes, derived from observations upon the higher animals. In fact, Partheuogenesis, in all its integrity, has now been observed in a large number of cases in the vegetable kingdom. The occurrence of seeds, independent of stamens, was first observed in a Euphorbiaceous plant in the gardens at Kew. It has been subsequently observed in a large number

of plants, a list of which, with the observer of the phenomenon, we subjoin:

CHARACEÆ.
Chara crinita, A. Braun.
CANNABINEÆ.
Cannabis sativa, Naudin.
CHENOPODIACEÆ.
Spinacea oleracea, Le Cocq.
EUPHORBIACEÆ.
Cœlebogyne ilicifolia, J. Smith.
Mercurialis, species, Naudin.
ANACARDIACEÆ.
Pistacia Narbonensis, Tenore.
Pistaciæ species, Bocconi.
CUCURBITACEÆ.
Bryonia dioica, Naudin.
DATISCEÆ.
Datisca cannabina, Fresenius.

Although this phenomenon looks, at first sight, so exceptional, a little reflection will show that it is in accordance with the general plan of the growth and reproduction of organized beings. In both the vegetable and animal kingdoms there are two plans of procedure,—one for the reproduction of the tissues of the same individual, in which single cells or parts resembling each other are produced. This is simply growth, and goes on whether the particular plant or animal forms one mass, or splits up into single cells or larger parts. This process we may call *Homogenesis*. In plants it produces buds (phytoids), bulbilli, bulbs, sporules, or any other parts like or unlike to the stock or part on which it is borne (isophytoids and allophytoids). In animals it produces buds or gemmæ (zooids), which, like the homologous parts in plants, are either like or unlike their parent-buds (isozooids and allozooids). Here will be found the "nurses" of Steenstrup, the "agamazooids" of Lubbock and Huxley, and the "virgin mothers" of Owen. The other plan may be called *Heterogenesis*. Here a new series of homogenetic actions is initiated. For this process two cells are required—a sperm-cell and a germ-cell. In the plant the phytoid changed in its form bears the sperm-cell and is called a stamen (androphytoid), or the germ-cell and is called a pistil (gynophytoid). These are combined, and we have a hermaphrodite flower (androgynophytoid). In the homologous parts in the animal kingdom we have separate male animals (androzooids) and female animals (gynozooids), and the two sexes combined in hermaphrodite animals (androgynozooids). By this mode of viewing the phenomena of Parthenogenesis, it will be seen

they belong to the series of homogenetic actions, and that we are gradually prepared for the remarkable development of buds into seeds amongst plants by such forms as bulbilli and sporules, and of buds into eggs amongst animals by a variety of transitionary forms.—E. L.

Adulterations detected, or Plain Instructions for the Discovery of Frauds in Food and Medicine. By ARTHUR HILL HASSALL, M.D. London, Longmans.

DR. HASSALL'S name is inseparably associated with the subject of adulteration. Whether he was the first to apply the microscope to the discovery of adulteration, or whether he has in all cases done so judiciously, there can be no doubt that of all persons he has used this instrument most largely in examining the adulterations practised in the preparation of articles of food for sale. It is indeed a triumph for the microscope, that in so many cases where the chemist was utterly unable to detect adulteration, it has perfectly succeeded. And thus it must be. Wherever sight assists us to the knowledge of the true nature of a thing, then the application of the microscope must facilitate observation and increase our knowledge. Already practical results of importance have followed on the publication of Dr. Hassall's observations as analyst of the celebrated "Lancet Sanitary Commission," and he has done great service to the cause of purity of food in the publication of the present volume. Although Dr. Hassall advocates a system of Government inspection of food, the publication of his book will go a long way to render such public interference unnecessary. The microscope is no longer alone a toy in the house of the wealthy, or an instrument of research in the study of the philosopher, but a part of the household arrangements of every intelligent family. With the aid of Dr. Hassall's book and a compound microscope, persons of ordinary intelligence will be able to examine for themselves the quality of their daily food. In fact, we do not despair of seeing the time when it shall be deemed a necessary accomplishment of every good housewife to be enabled to test the quality of all articles of food by the aid of the microscope.

Dr. Hassall makes the following sensible remarks on the

application of this instrument to the detection of adulterations:

"The microscope is specially suited to the detection of organized structures or substances, as the several parts of animals and plants: it is with the latter that we shall chiefly have to do in the course of the present work.

"When we survey with our unaided vision any animal or plant, we detect a variety of evidences of organization or structure; but there is in every part of every animal or vegetable production an extraordinary amount of organization, wholly invisible to the unarmed sight, and which is revealed only to the powers of the microscope. Now this minute and microscopical organization is different in different parts of the same animal or plant, and different in different animals and plants, so that by means of these differences, rightly understood, the experienced microscopical observer is enabled to identify in many cases infinitely minute portions of animal or vegetable tissues, and to refer them to the parts or species to which they belong.

"Thus, by means of the microscope, one kind of root, stem, or leaf may generally be distinguished from another, one kind of starch or flour from another, one seed from another, and so on. In this way, the microscope becomes an invaluable and indispensable aid in the discovery of adulteration.

"Applying the microscope to food, it appears that there is scarcely a vegetable article of consumption, not a liquid, which may not be distinguished by means of that instrument. Further, that all those adulterations of these articles which consist in the addition of other vegetable substances, and which constitute by far the majority of adulterations practised, may likewise be discovered and discriminated by the same means.

"The same remarks apply to all the vegetable drugs, whether roots, barks, seeds, or leaves. We are not acquainted with one such drug which may not be thus distinguished.

"The seeds even belonging to different species of the same genus may frequently be distinguished from each other by the microscope, a point in some cases of very great importance. A remarkable instance of this has fallen under our observation. The seeds of the different species of mustard, rape, &c., may all be distinguished under the microscope by differences in their organization. To show the importance of the discrimination in some cases, the following instance may be cited. Some cattle were fed with rape cake, and died with symptoms of inflammation of the stomach and bowels. Nothing of a poisonous nature could be detected on analysis; but it was suspected that the cake might be adulterated with mustard husk, although even this point could not be clearly established by chemical research. Under these circumstances the cake was sent to the author for examination, who had but little difficulty in ascertaining that it was adulterated with mustard seed, which, from the large quantity consumed, was doubtless the cause of the fatal inflammation. Not only can the seeds of different plants of the same genus be frequently discriminated by the microscope, but in some cases those belonging even to mere *varieties* of species.

"The microscope in some cases can even inform us of the processes or agents to which certain vegetable substances have been subjected. Illustrations of this are afforded by the starches of wheat and barley: it can be determined by the microscope whether these are *raw*, *baked*, or *boiled*, or whether *malted* or *unmalted*. Illustrative figures will be found in the articles on BREAD and BEER.

"Again, it is not only when the articles are in a separate state that they can be thus distinguished; but even when mixed together in different proportions. We have succeeded in detecting in certain vegetable powders no less than nine different vegetable productions.

"So great and manifest are the differences revealed by the microscope in different vegetable substances, that, with ordinary care and some amount of preliminary knowledge, the discrimination becomes a matter of the greatest ease and the most absolute certainty.

"Further, wonderful to relate, the grinding and pulverization, and even the charring, of many vegetable substances, does not so destroy their structure as to render their identification by the microscope impossible. Chicory and coffee may be thus roasted and pulverized, and yet each may be subsequently identified with the greatest ease, they being in fact but little changed, except in colour, and in the case of coffee by the dispersion of the droplets of oil visible in the cells of the unroasted berry.

"Again, substances may be discovered by means of the microscope, even when introduced into articles for the purpose of adulteration in extremely minute quantities: the case of some mustard forwarded by a manufacturer to the 'Lancet' some time since furnished a remarkable illustration in point.

"The mustard was stated to be genuine; but on examination with the microscope, it was found to contain a small quantity of turmeric. The manufacturer, when informed of the fact, very candidly and properly acknowledged that this was the case, and stated that he had added '*two ounces of turmeric to fifty-six pounds* of seeds, not for the purpose of gain or adulteration, but simply to enliven the colour and make its appearance more acceptable;' that is, the quantity of turmeric present, and discovered by the microscope, consisted of only *one part in* 448 of the quantity examined.

"The last illustration—and a very striking and beautiful one it is, although not immediately connected with the subject of adulteration—which we shall adduce in order to show the extraordinary character of the information furnished in some cases by the microscope is supplied by honey.

"Honey is the saccharine exudation from the nectaries of flowers: the bees in collecting it carry away some of the pollen of the flowers visited by them. Now this pollen consists of cells or vesicles, differing in size, form, and structure, according to the plants from which it is derived, certain plants being characterised by pollen granules of a certain configuration and organization. By the pollen present in honey, therefore, the scientific microscopist acquainted with the characteristics of the pollen of different plants is enabled to decide in many instances upon the nature of the plants from which the honey has been procured, and whether it has been collected from the flowers of the field, the garden, the heath, or the mountain. See article HONEY for figure in illustration.

"There is still another use to which the microscope may be applied in the detection of adulteration; it may frequently be made to serve as an auxiliary to chemical researches: thus, for example, when we want to ascertain whether any substance contains starch, carbonates, phosphates, &c., it is often the quickest and most certain way to apply the reagents, to a small quantity of the substance while this is under the field of vision of the microscope."

In this work, however, Dr. Hassall does not confine himself to the microscopical examination of objects, but wherever chemistry is capable of assisting he indicates the processes to be pursued. Nor is the book confined to food alone. In addition to all the ordinary eatables and drinkables, we have detailed accounts of the methods of investigating tobacco, snuff, opium, scammony, jalap, ipecacuanha, colocynth,

liquorice, and other drugs. It makes us indignant to read of the vile compounds that are employed to adulterate our food, but the iniquity becomes more atrocious still when we find that the remedies to which we fly for relief for the pains produced by the bad food are themselves all likewise adulterated.

Dr. Hassall's book is illustrated with upwards of two hundred engravings on wood, executed from original drawings by Mr. Henry Miller, Mr. Tuffen West, and Mr. Searson. These engravings are most efficiently executed, and comprise a series of very valuable microscopic illustrations. They are quite worthy the attentive study of those engaged in microscopic investigations, and as they are all devoted to the structure of very familiar objects, they may be very successfully used as a means of educating the eye in a variety of organic structures. We can recommend this volume to all who are engaged in microscopic inquiries, and especially to those who wish to turn their microscopy to practical advantage.

NOTES AND CORRESPONDENCE.

Nobert's Tests.—Most of those who take an interest in the microscope are, doubtless, well acquainted with Mr. De la Rue's calculations of the intervals which separate the lines in

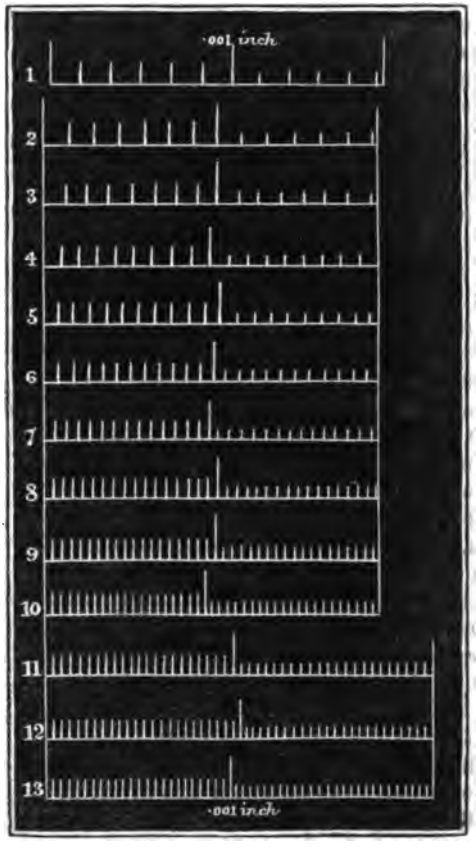


Diagram.

M. Nobert's marvellous productions, as given in Quekett's

'Treatise on the Microscope,' and Lardner's 'Museum of Science and Art,' vol. vi, p. 69, and, most probably, elsewhere. I believe, however, that many, to whom the subject is new, look upon these calculations with "the doubts of imperfect faith," or, "if they accept these measures at all" (to use the language of the Astronomer Royal, when speaking of very *different* measures, in his most instructive work, the 'Ipswich Lectures on Astronomy'), "they adopt them only upon loose personal credit." Under this impression, it has often occurred to the writer, that it would be both interesting and instructive to endeavour to draw the several groups of lines by the aid of the camera lucida, at the same time taking the $\frac{1}{1000}$th of an inch from the micrometer. This would afford, as it were, an *ocular* and *graphic* confirmation of Mr. De la Rue's calculations, sufficient to enable any one to satisfy himself of their general truth by mere inspection. This the writer has endeavoured to do, as shown in the accompanying diagram; and, though the method can only be considered rather rough and approximative, yet he apprehends that the risk of any serious error creeping in is only very small, and the table below shows that it is sufficiently exact to give very close approximations to Mr. De la Rue's results. The test-plate, which was used on this occasion, contains fifteen series of lines, and appears to be similar to the one mentioned by Quekett in his work on the 'Microscope,' p. 477, ed. 2. I have, however, only been able to transfer the first thirteen series, and in each series, in the drawing from which this was taken, the lines are represented as actually drawn with the camera, and, in order to present to the *eye* its relation to $\frac{1}{1000}$th of an inch, each series is most carefully continued by means of scale and compasses, so as to fill up the interval of 0·001 inch, such continuation being drawn in lines only *half* the length of those which represent the lines as dotted down from the test-plate. By this means, the approximate interval, which separates the lines of any series, can be obtained by mere inspection, the fraction of a division being taken by estimation. Thus, in the series No. 7, there are 28 intervals and about half an interval, or 28·5 intervals in 0·001 inch; consequently, in one inch, there are 28,500 such intervals, and the lines are distant from one another $\frac{1}{28500}$th of an inch. The results thus obtained are given in this table, side by side with Mr. De la Rues' calculations, and show as close an agreement as, I think, could possibly be expected by this method. The magnifying power in the first ten series is rather more than 1700 diameters, and in the last three above 2000, both estimated by the usual standard, ten inches.

TABLE.

	Number of lines in each band.		Distance of the lines in parts of an English inch.	
	De la Rue.	G. H.	De la Rue.	G. H.
1	7	7	$\frac{1}{11261}$	$\frac{1}{11250}$
2	8	8	$\frac{1}{13056}$	$\frac{1}{13330}$
3	9	9	$\frac{1}{15426}$	$\frac{1}{15500}$
4	10	10	$\frac{1}{18163}$	$\frac{1}{18000}$
5	11	12	$\frac{1}{20475}$	$\frac{1}{20500}$
6	13	13	$\frac{1}{23461}$	$\frac{1}{23750}$
7	15	15	$\frac{1}{28153}$	$\frac{1}{28500}$
8	17	18	$\frac{1}{32175}$	$\frac{1}{33000}$
9	19	20	$\frac{1}{37537}$	$\frac{1}{37500}$
10	21	21	$\frac{1}{40950}$	$\frac{1}{41500}$
11	23	23	$\frac{1}{45050}$	$\frac{1}{45000}$
12	24	25	$\frac{1}{47827}$	$\frac{1}{47660}$
13	26	25	$\frac{1}{50050}$	$\frac{1}{51000}$

I did not attempt the last two series, as I found it very trying to the eyes when the lines approximate so closely. The lines were viewed by a very fine $\frac{1}{12}$th of Powell and Lealand's, in my possession, mounted on one of Smith and Beck's stands, using their third eye-piece, the draw-tube being pulled out three inches in drawing the last three series; and I think it says much for the steadiness and perfection of Smith and Beck's stand (though only their smaller one, No. 2, on a single pillar), that under these high powers I was able to use the camera with ease and complete absence from tremor. The lines were illuminated by Messrs. Smith and Beck's achromatic condenser during the whole of the time that I made this drawing. I find that the smallest black stop, for cutting off the central rays in the revolving diaphragm of their condenser, when it is placed a very little on one side of the position concentric with the axis of the condenser, shows the finer lines with a sharpness and certainty which I have failed in producing by other methods of illumination which I have tried. In conclusion, I will add, there are several irregularities in the intervals in that part of the diagram which represents the lines as drawn by the camera, but whether these irregularities represent corresponding ones in the lines

themselves, or are the result of imperfect drawing, I am not able to say; most probably the latter.—GEORGE HUNT, Handsworth, Birmingham.

The "Rio de Sangu."—At the meeting of the Academy of Sciences in Paris, held October 6th, 1856, M. J. Rossignon read a note on the "Rio de Sangu" (River of Blood), in the territory of Honduras. The account of this extraordinary phenomenon, which to us appears scarcely credible, is as follows:

"This singular spring is found near the village of La Virtud, near Choluteca, between the states of Salvador and Honduras.

"The slender thread of water of which the spring is composed, flows constantly from a grotto formed of trachitic rocks. As it escapes from the source, the liquid presents the bright red hue of the blood of an animal recently killed. Its density is 2·75, and it has no sensible smell or taste. At a short distance, however, from the grotto it soon becomes changed, doubtless owing to the action of light, and above all to that of heat, which is very considerable in that country. It then acquires the smell of putrid flesh, which attracts the black vultures (zopilotls), the natural scavengers of those tropical regions, and who, when they have nothing better to devour, content themselves with this meagre diet.

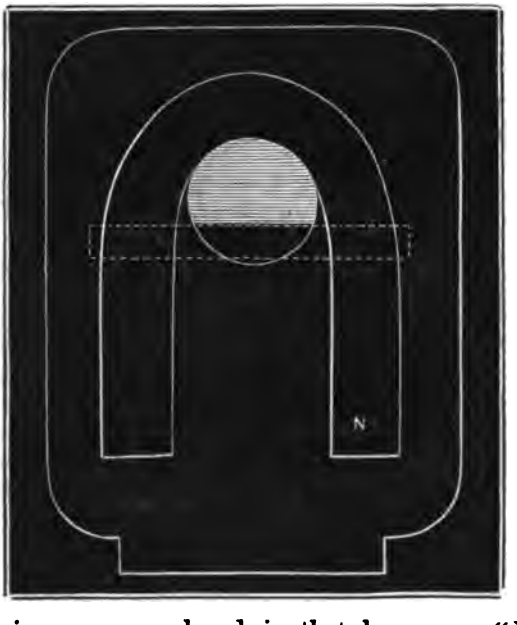
"The liquid is coagulated by acids, and the coagulum is redissolved by alkalies. Evaporated in a capsule, it first coagulates at a temperature of 80° cent., and then throws down a deposit, which readily swells up and assumes a reddish-black colour. Distilled in a close vessel this residue affords all the products of the decomposition by heat of animal substances, leaving a porous and very friable, azotized charcoal. It affords at the same time an ammoniacal, yellowish oil of nauseous odour, but which differs widely from the animal 'oil of Dippel.'

"M. Rossignon detected in this fluid a great number of infusory animalcules, having an elongated form, and to which he attributes its colour and peculiar properties.

"M. Rossignon has also observed, in the small streams in Guatemala, vermiform animalcules, moving with excessive rapidity, and decomposing very speedily after the water had become stagnant. This water soon acquires a reddish-brown colour, exhales a very strong putrid odour, which also attracts the vultures and other carnivorous birds. The author of this memoir has detected, under several other circumstances, in stagnant waters more or less coloured, ani-

malcules of an analogous kind, and which have not yet been studied."

A New Magnetic Stage.—In offering the following suggestions to your readers, I do not profess to have made any new discovery, forasmuch that all the best works descriptive of the microscope mention, at least, a magnetic stage, and Mr. Busk has afforded a detailed account of such an apparatus in the 'Microscopical Journal' for July, 1854 (No. VIII, pp. 280-1); but beg to suggest a far more simple, and I believe equally efficacious, form of instrument, which I have long employed with advantage, and which a single glance at the accompanying sketch will suffice to describe.*



The microscope employed is that known as "Warington's;" the brass object-plate is replaced by one of oak wood, into which one of the common horse-shoe magnets is imbedded, as shown in the drawing; the armature of the magnet thus becomes the object-holder, and provides completely for the universality of movement of the object with a readiness and equability of motion only attained by mechanical stages of superior construction.

* The sketch is the size of the original; the dotted lines represent the "armature" used as the object-holder.

It is not attempted to be inferred that so simple an instrument as I have described is intended to supersede the use of the mechanical stage when the microscope is furnished with one, but, in its absence, and then only, I offer it to every observer to whom economy is an object, as a substitute for the "sliding rest" usually supplied to "Warington's" and other cheap forms of microscope.

The advantages proposed by Mr. Busk are—1st, thinness of stage,—mine is exactly one-eighth of an inch; 2d, steadiness of motion,—mine has equal advantage; and 3d, its trifling cost,—mine cost me eighteen-pence, item, one shilling for the magnet and sixpence for the wooden stage. From inquiries I have made, I am led to believe that Mr. Salmon, of Fenchurch Street (who furnished the "Warington's"), could supply the magnetic stage in brass, instead of wood, at the same price as the present "sliding rest."

I shall be happy to show the instrument to any reader who may take an interest in the subject.—J. Newton Tomkins, F.R.C.S., Russell Place, London.

Facts on the Propagation of Actinia.—My aquarium affords at this moment a curious illustration of a mode of increase in a beautiful specimen of *A. dianthus*, which I do not remember to have seen noticed. Although special reproductive organs are well known to exist in the Actiniæ, it would appear that they are not actually necessary to the multiplication and continuation of the species, as this end can be as easily accomplished, and with as much certainty, by fissuration and self-multiplication. I have lately had an opportunity of witnessing both processes, in white specimens of *A. dianthus*.

In one, a fully formed offset was thrown out about half an inch from the foot; this continued to grow for some weeks, and was ultimately thrown off, having attained a considerable size. In another instance, the animal became so firmly adherent to the side of the glass, that, after having vainly endeavoured to detach itself, with an apparent degree of violence, it positively tore itself away, leaving behind six small pieces of the outer margin of the circular foot. Firmly glued to the side, these portions served for many days merely to mark the spot; at the end of a week I took a piece of stick, and was about to clean them off, when, much to my surprise, I saw that they retracted as soon as I touched them: in a few days more, I was still more surprised to see a row of tentacles round the head of each; and they have at this time considerably increased in size, so that my stock is richer by six perfectly formed Actiniæ. The parent certainly suffered at

the time, for it remained motionless at the bottom of the tank several days, before it again made any attempt to fix itself. The wounded parts have since healed, the repair completed, and the animal is as lively as before. It is remarkable that I have had no increase of *A. dianthus* by any other mode; and in other specimens, after ejecting the young through the mouth, they have very soon after died.—JABEZ HOGG, London.

Microscopic Slide-dryer.—Several friends, who kindly mount for me microscopic slides, having stated that they had a difficulty in hardening the balsam, though they had tried the various means suggested, (1) such as hanging them over a gas-lamp, (2) placing them on a hot-water apparatus and (3) in the fender before the fire, it occurred to me that a modification of the common cheese-toaster or Dutch oven would facilitate the object.

I have had two made, and have been informed by the friends who have used them that the apparatus completely answers the purpose, and is a great convenience to them, as affording the means of stowing the slides away during the time they are in hand.

In hopes that it may be of use to others, I have sent a description of the apparatus for insertion in the 'Microscopical Journal.'

Those I have had made are one foot square and three inches deep, with a sloping top; the cavity being furnished with six movable shelves, resting on ledges rivetted to the sides at equidistant spaces. The shelves are cut out on the centre, so that both sides of the glass slides are exposed, and furnished all round with a narrow, turned-up ledge. These shelves will hold one dozen slides each, so that the bottom of the case and the slides will hold seven dozens of slides.

A classical friend has proposed the name of *Retino-klibanon* for this apparatus, which I have called a *slide-dryer*. J. E. GRAY, British Museum, March, 1857.

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *January* 14*th*, 1857.

George Shadbolt, Esq., President, in the chair.

T. N. Tomkins, Esq., 8, Russell Place, Fitzroy Square; J. R. Steadman, Esq., Sharnbrook, Beds; J. A. Pigott, Esq., Albert Terrace, Bedford, were balloted for, and duly elected members of the Society.

A paper, by J. Quekett, Esq., "On the White Substance surrounding the Mealy Bug, an insect infesting the Vine," was read.

Another paper, by the same author, "On the presence of Fungi in living and decaying Wood," was read.

Mr. Ward announced the intention of the Master of the Apothecaries' Company to invite the Members of the Society to a Soirée at Apothecaries' Hall, on Tuesday, April 28th.

A Report from the Sub-Committee appointed to determine the best mode of constructing a uniform attachment for Object-Glasses was read.

February 11*th*, 1857.

(ANNUAL MEETING.)

George Shadbolt, Esq., President, in the chair.

Reports from the Council on the Progress of the Society during the past year, and from the Auditors of the Treasurer's accounts, were read. ('Trans. Micr. Soc.,' p. 131.)

The President then delivered an Address, which was ordered to be printed with the preceding Reports.

It was resolved that George E. Blenkins, Esq., be elected Joint Honorary Secretary with Mr. Quekett.

The election of officers and new members of Council took place, when the following were declared duly elected:

President.—George Shadbolt, Esq. *Treasurer.*—N. B. Ward, Esq. *Secretaries.*—John Quekett, Esq.; George E. Blenkins, Esq.

Four Members of Council.—T. H. Huxley, Esq.; E. G. Lobb, Esq.; W. Peters, Esq.; J. H. Roberts, Esq.

The Rev. T. Wiltshire, Rectory, Bread Street Hill; Dr. Cobbold, 27, Upper Seymour Street; James Wyatt, Esq., Coldstream Guards; James Macgregor, Esq., 55, York Terrace, Regent's Park; J. Moore, Esq., Grasmere Lodge, Lower Tulse Hill, were balloted for, and duly elected members of the Society.

The Society then adjourned to a soirée, at which about 350 persons were present.

March 4th, 1857.

GEORGE SHADBOLT, Esq., President, in the chair.

H. Morley, Esq., 4, Frederick Villas, East Brixton; W. A. Lloyd, Esq., 19 and 20, Portland Road, Regent's Park, were balloted for, and duly elected members of the Society.

Dr. Harley read a paper "On the Skin of the Frog." ('Trans.,' p. 148.)

Mr. Busk gave an abstract of a paper by Mr. Beardsley, "On a Deposit from a Lake in Cumberland." ('Trans.,' p. 146.)

April 15th, 1857.

GEORGE SHADBOLT, Esq., President, in the chair.

Dr. E. H. Vinen, 6, Chepstow Villas West; W. J. Sargenson, Esq., 5, Pall Mall, were balloted for, and duly elected members of the Society.

A paper, by H. Dean, Esq., "On a Parasitic Fungus," was read. ('Trans.,' p. 160.)

Mr. Ward made some observations on Mosses, and exhibited and described a large collection of those plants.

May 13th, 1857.

GEORGE SHADBOLT, Esq., President, in the chair.

R. Wilson, Esq., 80, Old Broad Street; J. E. Elliott, Esq., 4, Martin's Lane, Cannon Street; D. Scannell, Esq., Chapel Street, Grosvenor Place; John Miller, Esq., 36, Jermyn Street; Dr. M'Kinlay, Paisley, were balloted for, and duly elected members of the Society.

Dr. Farre read a paper on the early state of the Human Embryo. ('Trans.,' p. 161.)

Mr. Jackson exhibited and described a new form of Microscope.

June 10th, 1857.

GEORGE SHADBOLT, Esq., President, in the chair.

R. Farmer, Esq., 6, Manor Road, Upper Holloway, was balloted for, and duly elected a member of the Society.

A paper, by George Blenkins, Esq., "On a Human Ovum," was read.

A paper, by Dr. Donkin, "On a new species of Filamentous Diatom new to Britain," was read.

A Report from the Sub-Committee "On the best form of Universal Attachment of the Object-Glass," was read.

The meetings were then adjourned until October.

ZOOPHYTOLOGY.

In the 'Transactions of the Tyneside Naturalists' Field Club' has been published a "Catalogue of the Zoophytes of Northumberland and Durham," drawn up by Mr. J. Alder, whose unwearied industry and well-known powers of minute observation we are glad to see thus devoted to the subject of Zoophytology. The work, as it may be termed, is not a mere catalogue of the Sertularian Zoophytes and Polyzoa found upon the coasts of Northumberland and Durham, but includes numerous and copious observations upon various species, and more especially the descriptions of several new genera and species. In the introductory observations the following list is given of species characteristic of the north-eastern shores:

1. Cœlenterata.

1. Actinozoa.

Actinia digitata.
Anthea Tuediæ.
Pennatula phosphorea.

2. Hydrozoa.

Eudendrium rameum.
confertum.
Tubularia Dumortierii.
Halecium muricatum.
Sertularia tricuspidata.
" *fallax.*
" *filicula.*
" *fusca.*
Thuiaria thuja.
Plumularia Catherina.
" *frutescens.*
Grammaria ramosa.

2. Molluscoida.

1. Polyzoa.

a. Cheilostomata.

Gemellaria loriculata.
Cellepora Skenei.
Bugula fastigiata.
murragana.
Flustra truncata.
Carbasea papyrea.
Eschara cribaria.
Retepora beaniana.

b. Ctenostomata.

Farrella pedicellata.
Avenella fusca.
Alcyonidium mamillatum.

Many of which, Mr. Alder observes, are generally rare or wanting in the south and west. Comparing the marine Fauna of the above region with that of the south coast, the most striking deficiency is found in the Asteroid and Helianthoid orders, many genera in which are entirely wanting; as are likewise all the calcareous and corticated corals. Of the more conspicuous south country zoophytes we may note the absence of—

Sertularia nigra.
pinnata.
Plumularia pennatula.
Campanularia gelatinosa.
Anthea cereus.
Adamsia palliata.
Caryophyllia Smithii.

And, among the Polyzoa, of—

Membranipora Lacroixii.
Flustra chartacea.
Caberea Boryi.
Valkeria pustulata.

The catalogue contains 164 species, of which seventeen at least are believed to be new. Mr. Alder arranges them in the following orders and families:

ANTHOZOA.

1. Hydroida.			
Tubulariadæ	15		
Sertulariadæ	30		
Campanulariadæ	18		
Hydridæ	2	65	
2. Asteroida		3	
Helianthoida		10	78

POLYZOA.

Cyclostomata	11	
Cheilostomata	54	
Ctenostomata	14	
Pedicellinea	1	
Hippocrepia	6	86
		164

The more characteristic species of the different bathymetric zones are stated to be the following:

1. Littoral zone.

Sertularia pumila.
Actinia mesembryanthemum.
coriacea.

Lepralia verrucosa.
punctata.
Membranipora pilosa.
Flustrella hispida.
Alcyonidium hirsutum.

2. Laminarian zone.

Sertularia operculata.
Laomedea geniculata.
Campanularia Johnstoni.
Lepralia hyalina.
Membranipora membranacea.
pilosa.
Cellularia reptans.
Flustra foliacea.
truncata.
Alcyonidium hirsutum.

3. Coralline zone.

Tubularia gracilis.
Halecium halecinum.
Sertularia fallax.
filicula.
Antennularia antennina.
Plumularia falcata.
Campanularia Johnstoni.
dumosa.
Reticularia serpens.
Coppinia arcta.
Pennatula phosphorea.
Actinia crassicornis.
Cellepora pumicosa.
Gemellaria loriculata.
Membranipora Flemingii.
unicornis.
Flustra foliacea.
truncata.
Carbasea papyrea.

4. Deep water.

Eudendrium rameum.
Tubularia Dumortierii.
Sertularia tricuspidata.
abietina.
fusca.
Plumularia falcata.
Catherina.
Campanularia volubilis.
dumosa.
Grammaria ramosa.
Actinia digitata.
Diastopora obelia.
Cellepora ramulosa.
Skenei.
Lepralia reticulata.
linearis.

Cellularia ternata.
Peachii.
Bugula Murrayana.
Alcyonidium parasiticum.

The new genera and species described in Mr. Alder's 'Catalogue' are—

1. ANTHOZOA.

Fam. TUBULARIADÆ.

1. *Vorticlava.* Alder (p. 10).

Polype linear-cylindrical or clavate, soft, naked, affixed at the base, solitary (?). Head terminal; tentacles in two rows, stout, dissimilar, the upper row capitate.

1. *V. humilis*, n. sp. Alder (p. 10, Pl. I, figs. 1, 3).

Body white, semi-transparent; nearly of equal thickness throughout; upper tentacles 5, short and stout; lower tentacles 10, about three times the length of the upper. Length of body, $\frac{3}{10}$ inch.

Hab. On *Corallina officinalis*, between tide-marks. Cullercoats, also at Felixstow.

2. *Eudendrium*, Ehrenb.

1. *E. confertum*, n. sp. Alder (p. 13, Pl. I, figs. 5—8).

Polype white or pale flesh-coloured, with a longish ovate head, surrounded by a single row of tentacles. Polypary tubular, yellowish, horn-coloured, strongly wrinkled across, but not annulated, slightly branched and expanding a little towards the apertures; base, a densely reticulated and closely adhering crust. Height, $\frac{1}{4}$ to $\frac{1}{2}$ inch.

Hab. On old shells of *Buccinum undatum* and *Fusus antiquus* from deep water. Cullercoats.

2. *E. capillare*, n. sp. Alder (p. 15, Pl. I, figs. 9, 12).

Polypary minute, very slender, thread-like, a little branched, transparent, pale horn-coloured, smooth, excepting two or three faint rings near the origin of each branch. Polypes terminal on the upper branches, vase- or pear-shaped, with a single row of eighteen or twenty, long, slender tentacles; reproductive capsules on separate short branches near the lower part of the stem, or clustered on verticillate pedicles; two or three capsules in linear series on each pedicle. Height, $\frac{1}{2}$ inch.

Hab. Parasitic on *Antennularia ramosa.* Embleton Bay.

3. *Tubularia.*

1. *T. implexa*, n. sp. Alder (p. 18, Pl. VII, figs. 3—6).

Tubes small, very slender, generally more or less contorted below, smooth, wrinkled, or regularly annulated beneath a smooth, transparent epidermis; slightly and sub-unilaterally branched; the branches going off nearly at right angles to the stem, and a little constricted at their base. Gregarious, forming a densely tangled mass of $\frac{1}{2}$ to $\frac{3}{4}$ inch in height.

Hab. Deep water, thirty miles east of Holy Island.

Fam. SERTULARIADÆ.

1. *Sertularia*, Linn.

1. *S. tricuspidata*, n. sp. Alder (p. 21, Pl. II, figs. 1, 2).

Stem slender, alternately branched, twisted at intervals, and jointed above

each cell; cells alternate, rather distant, smooth, exactly cylindrical; a little bent outwards, with a three-toothed rim; ovicapsules strongly ribbed across, with a narrow funnel-shaped aperture. Height, 1 to 2 inches.

Hab. Deep water.

2. *S. tenella*, n. sp. Alder (p. 23, Pl. II, figs. 3, 6).

Minute, creeping, throwing up short unbranched or slightly branched stems, which are slender, zigzagged, and jointed above each cell; cells alternate, rather distant, elongate, barrel-shaped, finely wrinkled across; aperture erect, patent, squared, and four-toothed. Length, ½ to 1 inch.

Sertul. rugosa, var., Johnst.

Hab. Plum. falcata, and other zoophytes. Not common.

Fam. CAMPANULARIADÆ, Johnst.

Laomedea, Lamx.

1. *L. neglecta*, n. sp. Alder, p. 33, Pl. III, figs. 1, 2.

Polypary minute; stem filiform, sub-flexuose, with two or three alternate simple branches, each bearing a cell; the stem annulated, with from four to seven rings above the origin of each branch, and sometimes slightly ringed below; the branches ringed throughout, cells narrow and deep, with alternate deep and shallow crenations, forming about eight bimucronated denticles round the margin. Polype with fifteen or sixteen slender tentacles. Height, ½ inch.

Hab. Between tide-marks, on under side of stones.

2. *L. acuminata*, n. sp. Alder (p. 34, Pl. III, figs. 5, 8).

Polypary minute, scarcely branched, with a slender annulated stem; the annulations strongest at the base, and becoming fainter or disappearing towards the cell. Cells thin, membranous, finely striated longitudinally, elongate pod-shaped, squared below, and tapering to a fine point above; margin slightly crenulated. Polype, when extended, two or three times as long as the cell; tentacles 20, muricate, united by a web at the base. Height, $\frac{1}{10}$ inch.

Hab. Old shell of *Fusus antiquus* from deep water. Cullercoats.

2. *Campanularia.*

1. *C. Johnstoni*, n. sp. Alder (p. 36, Pl. II, fig. 8).

Stem creeping, plain; pedicles long, with numerous close-set rings at the base, and more or less ringed at the top; middle portion usually plain, sometimes ringed; cells deep and rather large, with ten to twelve strong denticles round the rim; ovicapsules nearly sessile on the creeping stem, ovate-oblong, strongly plicated transversely and truncated at the top. Length, one and a half to two tenths of an inch.

Hab. On seaweeds, zoophytes, shells, &c. Common.

2. *C. Hincksii*, n. sp. Alder (p. 37, Pl. II, fig. 9).

Stem creeping, plain; pedicles long, nearly smooth, with two or three slight spiral twists at the base and two or three spherical rings at the top, one of which is within the cup: cells rather long, with parallel sides, wrinkled or lineated longitudinally; marginal denticles 10, of a squared or castellated form, a little indented at the top. Height, about ⅛ inch.

Camp. volubilis, var., Hincks, in 'Ann. Nat. Hist.,' 2d ser., vol. ii, p. 180.

Hab. On shells and zoophytes from deep water.

3. *C. gracillima*, n. sp. Alder (p. 39, Pl. IV, figs. 5, 6).

Stem erect, compound, sub-unilaterally branched; cells very slender, long, tubular, thin, set on loosely twisted pedicles of about two whorls; aperture entire. Height, 1 inch.

Hab. On shells and zoophytes from deep water.

A very similar if not identical species occurs in Bass Strait (Busk).

3. *Grammaria*, Stimpson.

"Polypidom rectilinear, elongated, cylindrical, composed of aggregated tubes, generally without branches, which, when they occur, are of the same character as that from which they spring. Cells arranged on all sides, in more or less regular and equidistant longitudinal rows, giving a section of the stem a star-like appearance."

G. ramosa, n. sp. Alder (p. 40, Pl. IV, figs. 1—4).

Polypary stout, horn-coloured, irregularly branched; branches arising from a constricted base; cells cylindrical, bending outwards to a distance nearly equal to the width of the stem, with an even margin, behind which they are frequently annulated with one or two lines of growth; they are set in about four longitudinal rows, the adjoining cells alternating and the opposite cells nearly in a line with each other. Height, 1—2 inches.

Hab. Deep water; rather rare.

II. Polyzoa.

Fam. Membraniporidæ.

1. *Membranipora*, Blainville.

As considerable confusion and obscurity involve the various British species of *Membranipora*, a genus to which Mr. Alder appears to have paid considerable attention, and which he has in great measure now cleared up, it will be advantageous to notice his arrangement of the several species belonging to it which have occurred to his observation. These are—

1. *M. membranacea*, Linn. *Flustra membranacea*, Johnst. *M. membranacea*, Busk. Cat., p. 56, pl. lxviii, fig. 2.
2. *M. pilosa*, Linn., Johnst., Busk.
3. *M. lineata*, Linn. Alder (p. 53, Pl. VIII, figs. 1, 1*a*).

Cells oval; the margin with four or five spines on each side, bending inwards, generally rather slender and not flattened on the sides. Ovicapsule large, galeate, slightly frosted, with an arched rib near the top. Avicularia subsessile, or a little elevated, situated on one or both sides of the ovicapsule, more rarely at the top, and sometimes at the bottom of the cell.

Flustra lineata, Linn., Johnston.

Membranipora lineata, Busk. Cat., p. 58.

4. *M. spinifera*, Johnst. Alder (p. 53, Pl. VIII, figs. 2, 2*a*).

Cells oblong-oval; the margin with numerous stout, linear, or subclavate spines, about seven on each side, erect or leaning inwards. Ovicapsule shal-

low, smooth, with two or more spines (?). Avicularia, on the top of club-shaped spines, developed sparingly on any part of the margin of the cell.

Flustra spinifera, Johnst. 'Transact. of Newcastle N. H. Soc.,' vol. ii, p. 266, pl. ix, fig. 6.

Flustra (?) *lineata*, Johnst., 'Brit. Zooph.'

5. *M. craticula*, n. sp. Alder (p. 54, Pl. VIII, figs. 3, 3 *a*).

Cells in linear series, small, oval; margin with five to seven spines on each side, which are shining, flattish at the edges, and lie closely over the aperture; one or two of the uppermost spines are erect, long, and cylindrical. Ovicapsule rather small, smooth, and cylindrico-globose, with a rib across the middle. An avicularium generally at the top of the ovicapsule, sometimes at its side.

Hab. Deep water.

6. *M. Flemingii*, Busk. Cat., p. 58, pl. lxi, fig. 2; pl. lxxxiv, figs. 4, 5, 6; pl. civ, figs. 2, 3, 4. Alder, p. 55, Pl. VIII, fig. 4.

7. *M. Pouilletii*, Audouin.

Cells ovate, broadish below, rather larger than in *M. Flemingii*, and without the inner expansion; margin granulated with a thin rim; spines four or six, round the top of the cell, short; one only, on each side, visible below the ovicapsule. Ovicapsule large, globose, or elongated, strongly granulated and occasionally perforated. Avicularia dispersed; sometimes a small one on each side of the ovicapsule.

M. membranacea, Johnst.

M. Pouilletii, Audouin, 'Expl.' I, p. 240; Savigny, 'Egypt,' pl. ix, fig. 12.

8. *M. unicornis*, Fleming, (p. 56, Pl. VIII, fig. 6).

Cells stout, oval; margin granulated, with two spines on each side near the top, one of which is usually covered by the ovicapsule. Ovicapsule subcylindrical, smooth, with a strong rib above the margin and surmounted by a conical avicularium.

Flustra unicornis, Fleming.

Mem. membranacea, Johnst. (pars).

Lepralia squama, Dalyell.

2. Fam. CELLULARIADÆ.

1. *Bugula*, Oken.

B. fastigiata, Fab. Alder, p. 59.

Polyzoary one to four inches high, stout, bushy, irregularly branched; becoming purplish or rusty-red when dry; cells biserial, cylindrical, elongate, attenuated below; aperture wide above, elliptical below, with a stout cylindrical jointed spine at the upper and outer angles, and a denticle in front of it; no spine at the inner angle. Avicularium large, with a longish beak. Ovicapsules very shallow.

Sertularia fastigiata, Fab.

Cellularia fastigiata, Fleming, Dalyell.

Cellularia plumosa, Johnst., 'Brit. Zooph.,' p. 341, pl. lxi.

Hab. Laminarian zone. Very common.

3. Fam. SALICORNARIADÆ.

1. *Salicornaria*, Cuvier.

1. *S. sinuosa*, Hassall.

Doubts having been previously entertained with respect to the distinction of this form from *S. farciminoides*, Mr. Alder "found it necessary to subject both kinds to a careful re-examination." The result of which has confirmed him in the belief that they are really distinct species. The best character, he says, is found in the avicularium. This organ in *S. farciminoides* is semicircular and arched upwards; that of *S. sinuosa* is triangular and points downwards, always sloping a little to one side. In addition to this the form of the under lip of the cell differs in the two species: in *S. farciminoides* it is slightly arched in the centre; whilst in *S. sinuosa* it is quite straight, and rather projecting, with a sinus at each end.

We now quite agree with Mr. Alder in regarding the two species as distinct.

Sub-order. CTENOSTOMATA.

Fam. ALCYONIDIADÆ, Johnston.

1. *Alcyonidium*. Lamx.

1. *A. mamillatum*, n. sp. Alder (p. 64, Pl. V, figs. 3, 4).

Encrusting, semitransparent, brownish; covered with rather long, stout, and strongly wrinkled papillæ, from which the polypides issue; tentacles 16—18.

Hab. On old shells, deep water.

2. *A. albidum*, n. sp. Alder (p. 64, Pl. V, figs. 5, 6).

Encrusting, semitransparent, yellowish-white; general envelope inconspicuous; polypides prominent, ventricose, flask-shaped, sub-recumbent, becoming erect towards the aperture, which is truncated when contracted; tentacles 18.

Hab. The stem of *Plum. falcata*.

2. *Farrella*, Ehr.

1. *F. pedicellata*, n. sp. Alder (p. 68, Pl. VI).

Body (of cell) ovate-oblong, yellowish, transparent, with long and very slender pedicles, uniform in thickness throughout, arising from a creeping fibre; tentacles 12. Length of cell, $\frac{1}{35}$ inch.

Hab. Old shells of *Buccinum undatum* and *Fusus antiquus*, in deep water.

On some NEW BRITISH POLYZOA. By the Rev. T. HINCKS.

(*Concluded from* No. XIX, p. 176.)

THE following is the conclusion (accidentally omitted) of a paper which appeared in the last number of the 'Journal.' It completes the description of the *Alcyonidium hexagonum* (Hincks)—the *A. Mytili* of Dalyell.

The surface of the fleshy crust is thickly covered with small prominences, marking the point at which the polypide issues from its cell. The normal shape of the cells is hexagonal, but they are subject to many irregularities. The *septa* are well marked, and show distinctly on the surface. The polypides are laid lengthwise in the cells, and the orifice is at one extremity, and not central. Sir John Dalyell says that they have about fifteen tentacula. The ovaries occur as somewhat circular *papillæ*, scattered irregularly over the *cœnœcium*, within which the *ova* are distinctly visible. At the top of each ovarium, when the embryos are about to escape, an opening appears, and a small tube is gradually pushed forth to some distance. Through this tubular orifice they work their way by means of their *cilia*, and as soon as they have effected their escape begin to move with great activity through the water. I have seen seven pass from a single ovary in the course of a few seconds. The embryo is circular in form, white, opaque, and bears a striking resemblance to a *low-crowned hat*. The margin is fringed with *cilia*.*

The figure of *Sarcochitum polyoum* in Gosse's 'Marine Zoology' should, I think, be referred to this species. It bears no resemblance to the *Sarcochitum* of Hassall.

Hab. Salcombe, Devon; encrusting sea-weed, between tide-marks.

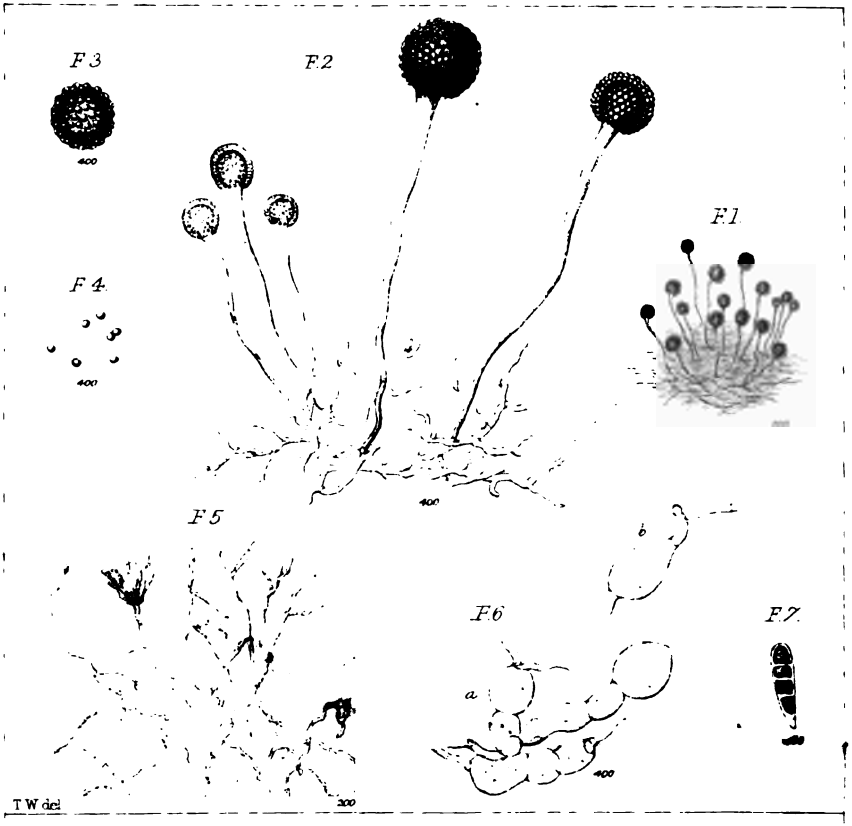
FARRELLA ELONGATA. [*Lagiuncula elongata*, Van Beneden.]

This species I have obtained in great abundance on the Lancashire coast, in the neighbourhood of Fleetwood and Lytham.

The pedicle is of very variable length, and the cells are *very slightly* attached to the creeping fibre. In this latter respect the species differs markedly from the *F. pedicellata*—a kindred form lately described by Mr. Alder. The tentacles of *F. elongata* vary in number from ten to fourteen. The former number is very common amongst the younger polypides; fourteen occur rarely, and twelve is the ordinary complement.

I recorded the occurrence of *F. elongata* in Britain some years ago, but the notice seems to have been overlooked (*vide* 'Micr. Journ.,' vol. iv, p. 95).

* In the 'Annals of Nat. Hist.' for November, 1851, I have described these embryos, referring them wrongly to the *Cycloum papillosum* of Hassall.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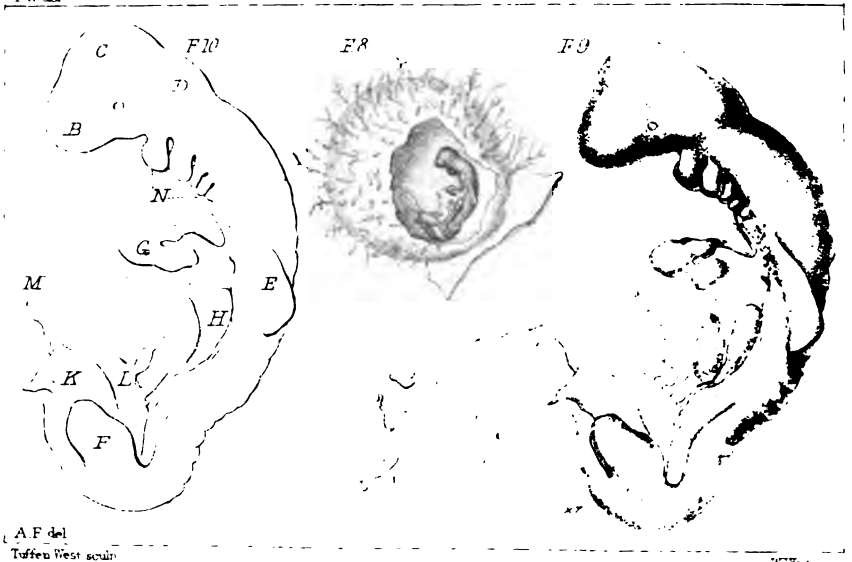
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DESCRIPTION OF PLATE VII,

Illustrating Mr. Grove's paper on a Fungus parasitic in the Human Ear, and Dr. Farre's paper on the Human Embryo.*

Fig.

1.—Appearance of the fruit of the fungus on the floccose mycelium, under a low power.

2.—Portion magnified 400 diameters, the dark "head" in the centre probably more matured than the remainder; most of the heads are smaller and of a fawn colour—such is the one represented on the right; the three on the left are in an early stage. Some of the mycelium is also shown.

3.—One of the "heads" viewed from above.

4.—Sporules detached in mounting; here and there amongst the mycelium were patches of them, probably nature-sown.

5.—Threads of mycelium ramifying beneath the surface, amongst the delicate hexagonal pavement epithelium; when it reaches the surface many short branches arise, as shown towards the upper left corner.

6.—Mycelium in a vesicular condition, perhaps from abundance of moisture in such part; it may be worth inquiry whether a process of true conjugation may not take place in such circumstances. The idea has been mooted before, and I have seen other instances which appear to add to its probability. *A priori*, it does not seem unlikely that a fungus, growing in an excessively moist locality or in water, may, in such alga-like condition, conjugate like an Alga.

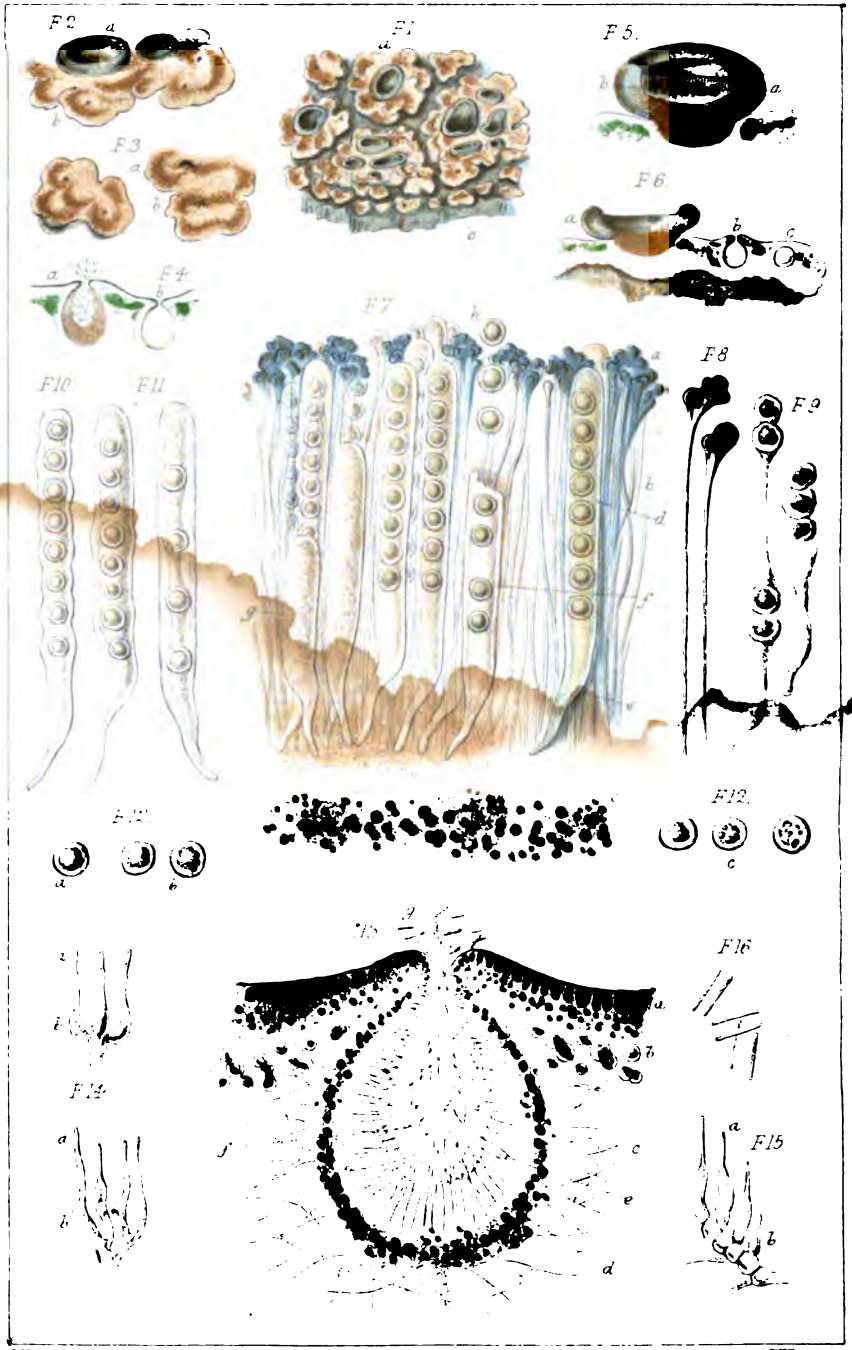
7.—An ascus, with four greenish sporidia, *on* a portion of the mycelium, whether accidentally or not, it may be difficult to say. No other example was seen; so that it may not have any connection with the other fungus.

8.—Embryo of the natural size contained in the fœtal membranes.

9.—The same embryo removed from the membranes, magnified 8 diameters.

B. Prosencephalon.
C. Mesencephalon.
D. Epencephalon.
E. Rudimentary upper extremity.
F. Lower ditto.
G. Heart, consisting of auricle, ventricle, and bulbus arteriosus.
H. Probably Wolffian body.
K. Root of allantois.
L. Probably a portion of rudimentary intestine, into which appears to open the remains of a vitelline vesicle. Behind this is a body in which rudimentary cells are seen (hepatic?)
N. Branchial laminæ (visceralbogen).

* Figs. 1—7 are multiplied 7 diameters.



W.L. Lindsay M.D. del. Tuffen West sc.

W. West imp.

DESCRIPTION OF PLATE XI,

Illustrating Dr. Lindsay's paper on *Lecidea lugubris*, Sommf.*

Fig.

1.—Fragment of the lichen, slightly magnified.
  a. Apothecia in different stages of development.
  b. Spermogones scattered over the squamules.

2.—Fragment of the thalline squamules, magnified, showing the—
  a. Apothecia.
  b. Spermogones.

3.—Sterile squamules, magnified, showing spermogones.
  a. Papillate ostiole.
  b. Depressed ostiole.

4.—Section of two spermogones—
  a. Having a papillate ostiole; and
  b. A depressed ostiole.

5.—Section of apothecium, magnified.
  a. Exciple or margin.
  b. Hymenium or thalamium.

6.—Section of apothecium and spermogones, showing their relative position.
  a. Apothecium.
  b. Mature; and
  c. Young, undeveloped spermogones.

7.—Section of apothecium, showing—
  a. Knobbed extremities of paraphyses.
  b. Filaments of ditto.
  c. Hypothecium.
  d. Mature theca: its body.
  e. Ditto, its pedicle.
  f. Ditto, ruptured, showing the mode of escape of the spores.

* The observations, upon which the drawings are based, were made chiefly under power 380 of a Nachet's microscope.

Fig.

g. Young thecæ in different stages of development.

h. Mature spores escaped from thecæ. The reaction of iodine on the thecæ, paraphyses, and spores is exhibited at *a*, *b*, *d*.

8.—Isolated paraphyses, showing the knobbed terminal cells—the seat of a dark indigo pigment—and the delicate filaments.

9.—Shrivelled or aborted spores, retaining the thecæ as caudate appendages.

10.—Mature thecæ, showing moniliform appearance, caused by distensions or bulgings of the cell-wall by the spores.

11.—Young theca, showing the development of few spores at intervals in a ribbon-like protoplasm.

12.—Spores.

a. Mature.

b. Young.

c. Old.

13.—Section of a spermogone, showing—

a. Cortical tissue of thallus.

b. Gonidic layer of thallus.

c. Medullary tissue of thallus.

d. Envelope of spermogone.

e. Sterigmata forming inner walls of spermogone.

f. Cavity of spermogone full of free spermatia mingled with mucilage.

g. Free and mature spermatia escaping by ostiole.

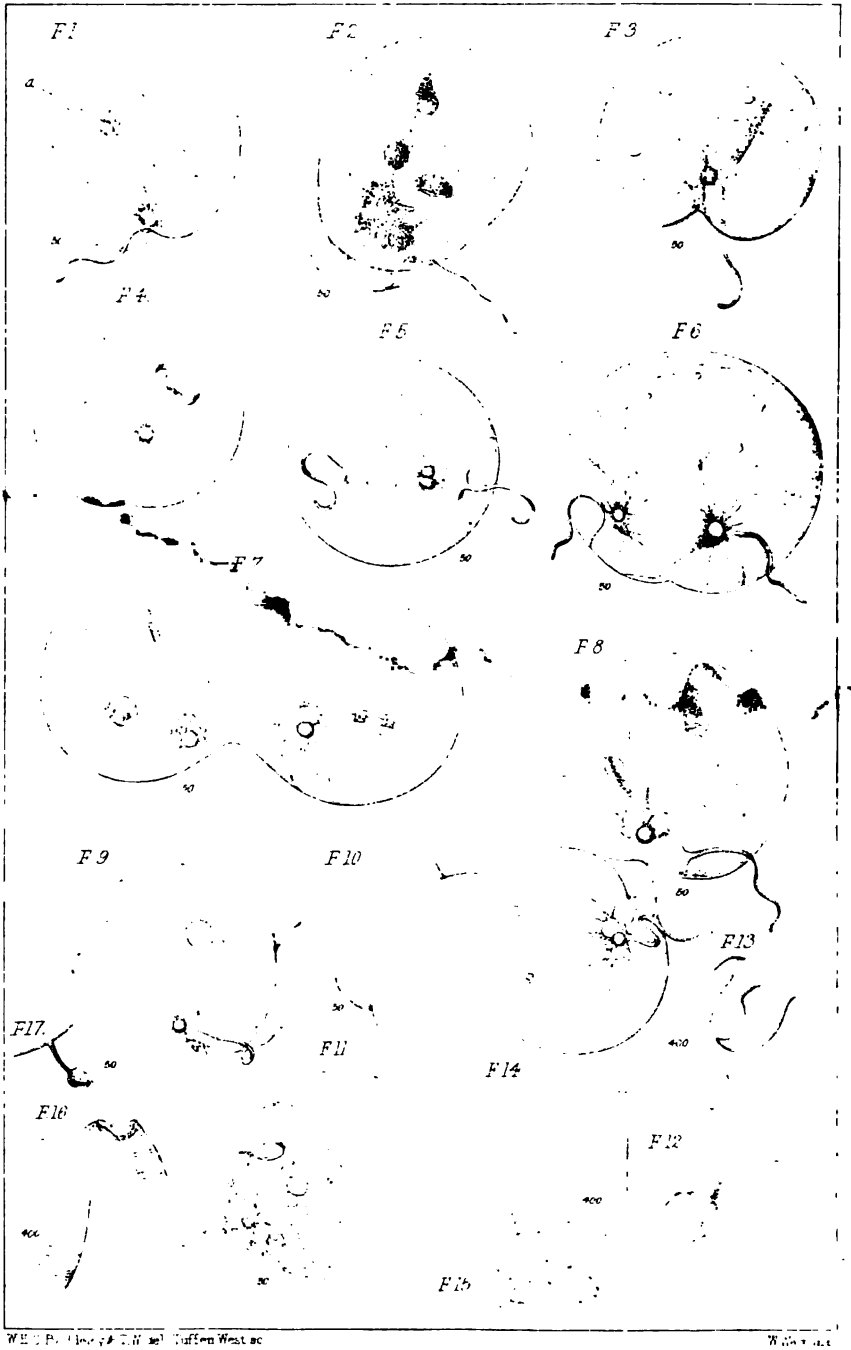
14.—Sterigmata and spermatia.

a. Spermatia.

b. Sterigmata.

15.—Sterigmata arising from articulated, thick, ramose tubes.

16.—Free, mature spermatia.



W.E.P. Clay & Son del. Griffen West sc.

DESCRIPTION OF PLATE XII,

Illustrating Mr. Brightwell's paper on Noctiluca.

Fig.

1.—Front view, showing the tail, cilium, &c.
   a. A vacuole containing a bright red-brown granular mass.

2.—Side view, showing pyriform shape, position of the fissure, &c.; structure obscure, from the quantity of food contained in the animal, a recently captured specimen.

3.—View showing the somewhat thickened angular portion; the nucleus is generally situated opposite to this, as well as the origin of the tail, so as to be indistinct in this view.

4.—Specimen in which the tail was undeveloped; most of the individuals taken during the winter months were thus imperfectly formed.

5.—Early stage of self-division: division of the nucleus has just taken place. The perfect development of the new tail at this period is remarkable.

6.—Division somewhat further advanced; the nuclei have removed far apart and a fissure is commencing. The vacuoles in this individual (which was drawn with great care) have almost entirely disappeared.

7.—Shows a further progress towards division.

8.—Shows self-division nearly complete, and two individuals now only held together by a slender cord.

9.—An individual just after complete separation and before the connecting portion is absorbed.

10.—Abnormal portion of the body thrown off by the animal, and in which no nucleus is found.

11.—Shows the effects of gentle, steadily continued pressure. At the first an appearance, as of a most delicate sac, is protruded, into which the globules, vacuoles, and sometimes the nucleus are received. The inner menbranes peel off from the cell-wall, and when the contents are out the creature suddenly collapses entirely. The appearance of the sarcode (membrane and threads) gently leaving its connections, "like threads of a very viscid liquid," and collapsing, is very remarkable.

12.—Oral orifice, &c., × 200.

13.—"Prehensile organ" and "trembling organ," × 400.

14.—Cell-wall, × 400; a tolerably thick, firm, and resisting structureless membrane.

15.—Sarcode membrane, with its thickenings, forming the immediate internal investment of the cell-wall. The thicker portions form a tolerably regular network over it; from these spring the fibrils.

16.—Tail, showing a section, × 400. This is concave in the part which comes in apposition to the body, and convex in the part which reaches beyond the body.

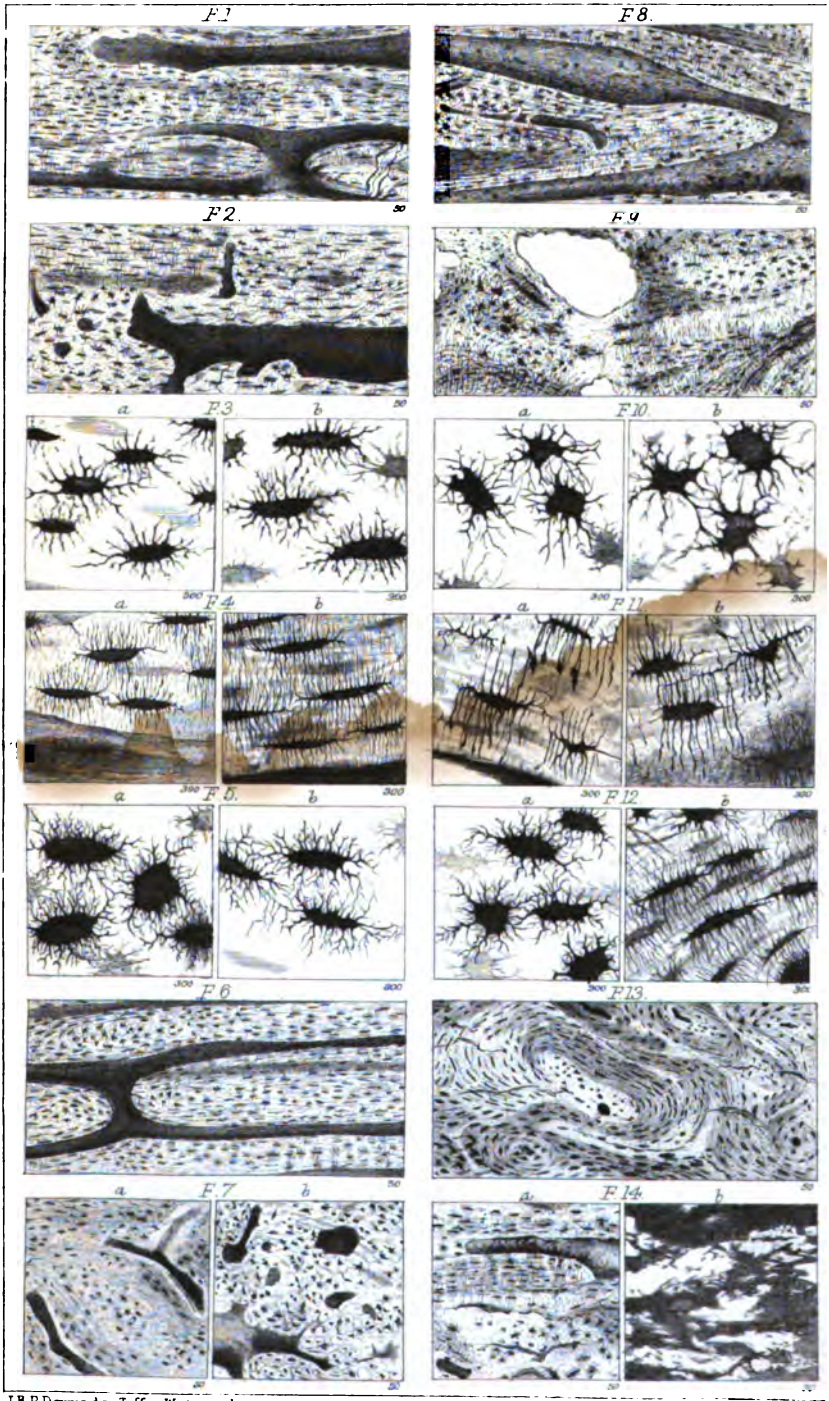
DESCRIPTION OF PLATE XIII,

Illustrating the Rev. J. B. Dennis's paper on the Microscopical Characters of so-called Cetacean Bones of the Red Crag.*

Fig.

1.—Crag fossil from detrital bed, Red Crag.
2.—Drift elephant.
3.—*a.* Free lacunæ of Crag fossil, detrital bed, Red Crag.
b. Free lacunæ of Drift elephant.
4.—*a.* Haversian lacunæ of Crag fossil, detrital bed, Red Crag.
b. Haversian lacunæ of Drift elephant.
5.—*a.* Hippopotamus.
b. Rhinoceros.
6.—Crag fossil, detrital bed, Red Crag.
7.—*a.* Crag fossil, detrital bed, Red Crag.
b. Fossil elephant from Himalayan mountains.
8.—Jaw of Greenland whale.
9.—Vertebra of fossil whale.
10.—*a.* Free lacunæ of Greenland whale.
b. Free lacunæ of fossil whale.
11.—*a.* Haversian lacunæ of Greenland whale.
b. Haversian lacunæ of fossil whale.
12.—*a.* Free lacunæ of recent elephant.
b. Haversian lacunæ of recent elephant.
13.—Crag fossil from detrital bed, Red Crag.
14.—*a.* Elephant from Suffolk Gravel.
b. Decomposed recent cetacean bone.

* Figs. 3, 4, 5, 10, 11, 12, are magnified 300 diameters, the remainder 50 diameters.



J.B.P. Dermis dir. Tuffen West sc. ad nat.

DESCRIPTION OF PLATE I,

Illustrating Mr. Hepworth's paper on the Practical Use of the Microscope.

Fig.

1.—*aa.* Exudation corpuscles.

b. The same, having undergone a slight change.

c. The same, having undergone a further change.

dd. Fully developed vegetations.

e. Crystals of oxalate of lime.

2.—*a. Sarcina renis.*

bb. Epithelial scales.*

c. Part of one of tubuli uriniferi.

d. Casts of ditto.*

3.—Aphthæ from a case of consumption.

4.—Ordinary aphthæ (thrush) in children.

5.—Longitudinal section of diseased intestine.

a. Thickened scirrhous peritoneal coat, the outer portion being dark brown, fibrous, and striated, the striæ being transverse to the section.

b. Outer cellular tissue containing—

cc. Blood-vessels.

d. Outer aponeurosis of what should have been the muscular coat.

e. Cellular tissue (in place of muscular coat, which was wanting) passing at intervals through—

f. The inner aponeurosis of muscular coat.

ggg. Masses of coagulable lymph.

h. Reflected mucous membrane.

* The epithelial scales and casts were not from the same subject; it is from a drawing I took some time ago, and having often met with scales of this colour with casts, I have introduced it here.

DESCRIPTION OF PLATES III, IV, V,

Illustrating the Hon. and Rev. S. G. Osborne's paper on Vegetable Cell-formation, principally as shown in the Growth of Wheat.

PLATE III.

Fig.

1.—Seed of wheat germinating, slightly enlarged.
- A. Green future blade, &c.
- B. Seed, starch, gluten, &c.
- C. Main root.
- DD. Lateral roots.
- EEE. Free cones of cells at the points of the roots.
- F. Hard cellular matter, the base of growth of root and stem.
  - α. Cellular tissue, the original covering of embryo blade.
  - β. Ditto of root.
  - γ, γ. Rootlets.
  - δ, Course of bundle of dotted fibre.
  - $\epsilon, \epsilon, \epsilon$. Suckers.
  - ζ. Course of spiral fibre.

2.—Section from junction of germ with seed.

2 *a*.—The sap-tube on a larger scale.

3.—Thick-walled cellular tissue, with dark granular matter and oil, connecting the bundles of fibre and their investing cells with the germinating point.
- *ab*. Layers of cells in immediate connection with—
- *c*. Thick-walled cells containing oil.

4.—Termination of rootlet slightly magnified, with its free capsule of cells, *d*, and suckers.

5.—Capsule enlarged.

6.—Centre of apex of young root.

7, 7*.—Stages of growth of suckers from side of root.
- *f*. Suckers.
- *g*. An escaped nucleus with its nucleolus.

8, 9.—Growth from side of root.
- *h*. Nuclei in egg-shaped vesicles.
- *i*. Hyaline thread-like processes.

10.—Cell-increase.

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